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AN ANNOTATED BIBLIOGRAPHY OF AVAILABLE LITERATURE REGARDING CETACEAN INTERACTIONS WITH TUNA PURSE-SEINE FISHERIES OUTSIDE OF THE EASTERN TROPICAL PACIFIC OCEAN

By

MEGHAN A. DONAHUE and ELIZABETH F. EDWARDS

ADMINISTRATIVE REPORT LJ-96-20

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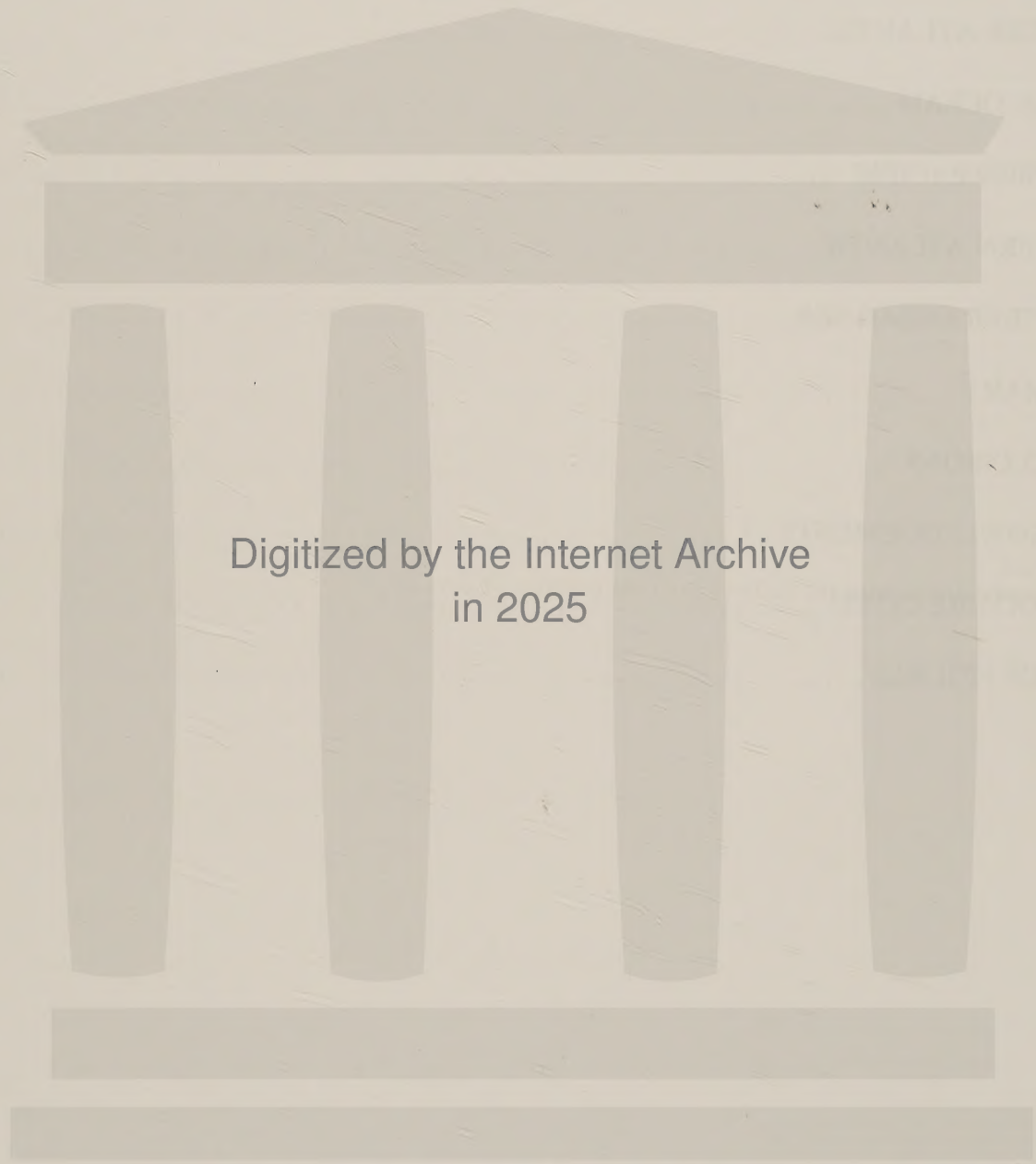

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ABSTRACT

A review of currently available literature concerning interactions between tuna purse-seines and dolphins outside the eastern tropical Pacific Ocean (ETP) does not indicate any large, sustained, or widespread practice of setting purse seine nets around cetaceans for the purpose of catching tuna in any oceanic area other than in the ETP. While a number of individual reports exist of purse-seine sets made on cetaceans during the process of fishing for tuna in areas other than the ETP, there is no quantitative or even anecdotal indication that large-scale sustained directed fishing on cetaceans during tuna purse-seining occurs anywhere other than in the ETP.

However, this lack of information should not be mistaken for conclusive evidence that such large-scale directed efforts do not exist. While it seems unlikely that a large-scale fishing effort would entirely escape notice for long periods of time, the existing available data were collected during at most only a very few percent of the sets made by purse-seiners in any of the fisheries, and thus represent only a very tiny fraction of the total effort being expended world-wide on tuna purse-seining.

The question cannot be resolved with only the information currently available. Conclusive answers will depend upon securing valid data comprising a much larger fraction of fishing effort by each tuna fleet operating outside the ETP. This would likely require a substantial investment in scientific observer programs, but the results would then be unequivocal. Existing reports could be used to provide a basis for directing such programs first to specific geographic areas with the largest existing number of data collected, e.g., off the western coast of Africa near Cape Palmas, or near the Seychelles in the Indian Ocean. At present, the best that can be said is that the few data available do not indicate a large-scale practice of setting on cetaceans for the purpose of catch tuna outside the ETP.

INTRODUCTION

Of tuna purse-seine fisheries around the world, the yellowfin fishery in the eastern tropical Pacific (ETP) is perhaps the most well-known owing to the role dolphins play in that fishery. This report summarizes information on tuna purse-seine fisheries in all areas excluding the ETP to determine the state of knowledge regarding these fisheries and any interactions with cetaceans they may have. This document does not determine the true frequency with which dolphins sets outside the ETP occur. Likewise, it does not determine whether or not the number of dolphins sets occurring outside the ETP is significant. This document provides an annotated bibliography of the currently available literature pertaining to cetacean involvement in tuna purse-seine fishing primarily in areas with large, commercial tuna fisheries such as the western Pacific, eastern tropical Atlantic, and Indian Oceans.

This bibliography is as comprehensive as possible in reviewing available information on tuna purse-seine fishing in all areas of the world excluding the ETP. It is very likely that more reports and data on this issue exist but such reports tend to be for limited distribution (not publicly available) and consequently were not available for review in this document. Annotations of the literature presented here summarize the contents of each paper with as little interpretation as possible. Much of the information in the original sources is more qualitative in nature than quantitative. Quotation marks appear around such qualitative assessments or conclusions to alert the reader that the wording reflects the original document.

Commercial tuna purse-seine fisheries were the original focus of the report but as information on 'local commercial' or 'national' fisheries surfaced, its inclusion seemed relevant. The purse-seine vessels used in such fisheries are smaller than their foreign-owned commercial counterparts and generally make shorter trips closer to shore. Distinguishing these local commercial or national commercial fisheries from even more coastal 'artisanal' fisheries in the literature is sometimes problematic. Although this report does not specifically address 'artisanal' fisheries, some 'artisanal' fisheries may use purse-seining methods which have been shown to capture small cetaceans (e.g. Maigret 1990, in this bibliography). The report does not intend to be comprehensive regarding 'local commercial' or 'artisanal' fisheries.

Available information on cetacean involvement in purse-seine fisheries outside of the ETP is sparse when compared to that available for the yellowfin tuna purse-seine fishery in the ETP. The fisheries for which the most information is available occur in the eastern tropical Atlantic, the western Indian Ocean, and the western Pacific. Purse-seine tuna fisheries also occur in other areas such as the Mediterranean and the western Atlantic but on a smaller scale.

Commercial tuna purse-seine operations began in the eastern tropical Atlantic in the 1960s (Fig. 1). Purse-seine fishing occurred mainly in the Gulf of Guinea and extended from Sierra Leone to Angola. In the 1970s the fishing grounds expanded farther offshore. Purse-seine vessels from France, Spain, the United States, and Japan began fishing in the region. When vessels from Ivory Coast, Senegal and Morocco began fishing there they, along with the French vessels, became known

as the FISM fleet (French/Ivoirian/Senegalese/Moroccan fleet). The FISM, Spanish and American fleets comprised the majority of vessels fishing in the area in the 1960s and 1970s. Because of increased exploitation, some of these fleets moved their operations to the western Indian Ocean in the early 1980s. Foreign commercial purse-seine vessels from the FIS (the FISM fleet without Moroccan vessels) and Spanish fleets currently operate in the area along with local commercial fleets from several of the countries along the west African coast.

Although a few purse-seiners were operating in the western Indian Ocean (Fig. 2) between 1979 and 1983, it was only after 1983 that purse-seine catches became significant in this area. The fishery expanded rapidly landing 100,000 mt by 1984. Purse-seine fleets from France, Spain, Japan, and Russia still fish in the western Indian Ocean from ports in Seychelles.

Beginning in 1977 several exploratory charters investigated the potential for developing large-scale commercial tuna purse-seine fishing in the western Pacific (Figs. 3, 4, and 5). Japanese purse-seine vessels had been already fishing in the area for several years when the exploratory charter trips indicated that there was potential for purse-seiners operating in the eastern tropical Pacific to fish successfully in the western Pacific. As of 1993, vessels from at least 11 nationalities were purse-seine fishing in the western Pacific. Commercial purse-seine fishing for tuna also occurs on a municipal level around Japan, New Zealand, and Australia, and in the Philippines.

Although several of the references in this bibliography suggest that tuna do not associate with dolphins in the Atlantic, Indian, and western Pacific Oceans as systematically as they do in the eastern tropical Pacific, tuna-dolphin associations have been sighted and deliberately set upon in these areas. Whether the occurrence of these sets represent a significant proportion of the total sets in these areas is difficult to determine given the few data available. Quantitatively determining whether significant numbers of dolphin sets are being made outside of the ETP is outside the scope of this report. The available data are difficult or impossible to standardize because of the inconsistency in methods with which the data were collected and in the durations of such data collection efforts. In addition, the existing literature does not sufficiently address questions regarding the reliability of data and the degree to which they are representative of total fishing effort. Even if one could resolve these deficiencies and arrive at a quantitative assessment of the frequency of dolphins sets, additional quantitative information, especially abundance information regarding the dolphin populations in these areas, would be necessary for such an assessment to be meaningful in terms of the fishery's effect on cetacean population dynamics. This additional information, too, is lacking. The references reviewed in this annotated bibliography illustrate these deficiencies in the current state of knowledge regarding cetacean interactions with tuna purse-seine fisheries outside of the eastern tropical Pacific and hopefully will provide incentive to remedy at least some of them.

The available literature on cetacean interactions with and mortality resulting from tuna purse-seine fishing operations is summarized below in chronological order by region. A summary of information from each region and conclusions based on those summaries appear following the regional summaries.

EASTERN ATLANTIC

Bane, G.W. Jr. 1961. The distribution and abundance of tunas and tuna bait fishes in the Gulf of Guinea. M.S. Thesis, Cornell U. 119.

The author participated in a cruise aboard the long-lining vessel *Columbia* to assess the abundance of tunas and tuna bait fishes in the Gulf of Guinea, sponsored by Starkist Foods, Inc. (a U.S. cannery) and the Ghana Fisheries Department. Sighting dolphins was one of the methods used by the crew to locate tuna schools. The author reports that dolphins swimming and feeding in association with tunas could be spotted leaping into the air up to ten miles away on a clear day. In addition to a daily operations log, a special fishing log was maintained to record schools of tunas, whales, dolphins, and other animals. Data recorded for each school included date, time, position, surface temperature, amount of fish caught, species composition of school, size of school, size of fish, and how well the tuna took the bait. The sighting summaries at the end of the thesis contain no records of tuna schools associated with dolphins, although several schools of each were seen. On one occasion, "three- and four-pole" tuna were reported as seen feeding with birds and whales. On a separate occasion, many skipjack and black skipjack tuna were reported as feeding with blue whales on anchovies. Apparently no fishing was conducted in either case.

Simmons, D.C. 1968. Purse-seining off Africa's west coast. Comm. Fish. Rev. March, 1968. 21-22.

Simmons collected data while aboard the U.S. purse-seiner M/V *Caribbean* from 2 October to 6 December 1967. He reports a total of 49 sets were made during this time. Eight of these sets (16.2%) were made on common dolphins (*Delphinus delphis*) off Cape Palmas. All eight sets were successful and caught pure schools of large yellowfin (950 mm forklength and above). Two sets that were not associated with dolphins were made in this same area, but these sets captured only small tunas and *Auxis*.

Honma, M., K. Hisada and S. Kanno. 1969. Tuna fisheries with the use of pole-and-line and purse-seine, and their yellowfin stocks along the western coast of equatorial Africa. Bull. Far Seas Fish. Res. Lab. No. 2. 85-113.

Data from Japanese purse-seiners fishing in the eastern equatorial Atlantic between January and July 1967 report that one set was made on tuna associated with dolphins and 39 sets were made on whales associated with dolphins. Total sets numbered 422. Thus, 0.2% of reported sets were on dolphins and 9.2% of reported sets were on whales. The majority of reported sets (47.9%) were made on "free-swimming" schools. Reported sets on tuna-bird associations (40.9%) comprised the majority of "associated" tuna school sets.

Di Palma, S. 1970. Memorandum to G. Howard and response from A. Longhurst regarding French tuna fishery out of Abidjan, Ivory Coast.

Mr. Salvatore Di Palma, Regional Fisheries Attaché in Abidjan, had talked with Mr. A. Lassarat, Director of the Fisheries Service in Abidjan, who wanted information on how to handle porpoise during tuna purse-seining operations. Di Palma states, "In the main, this is the problem. The French vessels are taking too many porpoise; they try to follow the American technique but many of the porpoises are getting their long noses caught in the mesh and drowning. The *Biscaya*, the large Marco-designed French seiner, had 35 tons of porpoise and 30 tons of tuna when it pulled into Abidjan recently."

In a second letter to G. Howard, Regional Director of the Bureau of Commercial Fisheries in California, Di Palma said after speaking to Lassarat again that it was not clear whether the dolphins from the *Biscaya* were unloaded at the port in Abidjan. Rather, the dolphins may have been brought on board, but later dumped at sea before the vessel returned to port.

van Bree, P.J.H. 1971. Letter to V.B. Scheffer, 22 February 1971.

After a visit to Abidjan, Ivory Coast, van Bree learned that purse-seining by encircling dolphins was "commonly" used in west African waters by vessels of "all nations." He cites one example of a set made off the Liberian-Ivory Coast border in February 1970 that caught 60 tons of tuna and 40 tons of dolphins (*Stenella frontalis* and *Stenella coeruleoalba*). According to fishery biologists at the Institut Français de Recherche Scientifique pour le Développement en Coopération (ORSTROM), the Food and Agriculture Organization of the United Nations (FAO) and the State Service (in Abidjan), "fewer and smaller" schools of dolphins were seen in the Spring of 1970 in Ivory Coast's waters. van Bree heard purse-seining is also used off Mauritania and in the Indian Ocean near Somalia. Talks with captains of fishing boats unloading at Abidjan convinced van Bree that they do "little or nothing" to keep the dolphins alive.

Levenez, J., A. Fonteneau and R. Regalado. 1980. Resultats d'une enquête sur l'importance des dauphins dans la pêcherie thonière FISM. ICCAT, Coll. Vol. Sci. Papers. 9(1):395-400.

Logbook data collected from the FISM fleet (French/Ivoirian/Senegalese/Moroccan vessels) operating in the eastern tropical Atlantic from January 1976 to June 1979 are compared with information gathered from interviews with 30 FISM skippers during the summer of 1979.

All of the FISM skippers interviewed said the association between tuna and whales was "common," but the association between tuna and dolphins was "rare." However, the area between Senegal and Cape Palmas was cited most often (23 responses), especially the Cape Palmas area which was mentioned seventeen times, regarding the frequency of tuna-dolphin associations. Seven skippers had no opinion on the subject of where tuna-dolphin associations occurred most frequently. Seven skippers estimated tuna-dolphin associations to be most common on the high seas, whereas nineteen skippers felt such associations were more common in the coastal zone. Twenty-two skippers said they had never captured dolphins while seven skippers acknowledged having made "no more than a dozen" sets in which dolphins were captured. These skippers estimated an average of

fifteen dolphins caught and killed per set. No skipper estimated having made more than ten sets on dolphins per year (the authors state a FISM seiner makes approximately 300 sets per year).

The logbook data that the interviews were compared with account for 70% to 80% of the FISM fleet. The following table represents the number and percentage of tuna schools associated with dolphins and whales as recorded in the logbooks. The total number of tuna schools recorded in the logbooks over the four years was 1, 479.

Schools associated with:	1976	1977	1978	1979 (first half)
Dolphins	0 (0%)	8 (1%)	11 (2%)	11 (4%)
Whales	13 (5%)	106 (22%)	85 (16%)	51 (20%)

Except in "rare" cases which look good on sonar, skippers in this area are reported as generally considering dolphins "poor indicators" of potential catch. They felt that tuna schools associated with dolphins were generally small (approximately 2 to 3 tons) and are not easily accessible because they swim deep. Furthermore, they reported that dolphins do not jump over the net, but get their beaks caught in the mesh. For them, these conditions did not justify setting the net given the potential for small catches and the difficulty in untangling the dolphins from the net. It is noted, however, that tuna schools of fifteen to twenty tons were observed in association with small groups of two to fifteen dolphins.

Baleen whales reportedly served as a systematic indicator in the search for tuna and, if a whale was sighted, the boat would pursue the animal.

Maigret, J. 1981. Rapports entre cétacés et la pêche thonière dans l'Atlantique tropical oriental. Notes Africaines. 171:77-84.

According to Cadenat (1958) [Alverson (1991) notes that this may be Cadenat, 1959], four dolphin species have apparently been observed in association with tunas, as was the specimen which was reportedly captured in South Saloum in July 1957 in waters 200-300 meters deep in the yellowfin fishing grounds. (No further information is provided on the capture of this dolphin). Maigret states that the association had been reported by "most" tunaboat captains (both baitboats and purse-seiners), who apparently use dolphins as an indicator of the presence of tuna. In Dakar, several fishermen said during interviews that cetaceans, like seabirds, were good indicators of the presence of tunas.

However, "captains of tuna vessels" said they avoided setting on dolphins because if the dolphins get caught and drown they cause the net to sink and make it difficult to roll aboard, or they cause the net to tear which leads to loss of fish and damage great enough not to warrant setting on

dolphins. These same captains stated that U.S. seiners operating offshore did capture dolphins because they do not hesitate to set on dolphin schools, which they first corral with speedboats as in the eastern tropical Pacific.

When interviewed, "scientific researchers who study the tuna fishery" felt the dolphin problem was "minimal" and that catches of cetaceans in purse-seines are "much less alarming" than in the eastern tropical Pacific.

Maigret obtained the fishing records collected by the Centre de Recherches Océanographiques (CRO) in Dakar-Thiaroye and in Abidjan for 1976 and 1977. The data on cetaceans were extracted, but the records are supposedly not very accurate because not all of the captains record the presence of cetaceans. For large seiners unloading in Abidjan in 1976, none of the captains reported catching dolphins. Sets on whales reportedly occured "occasionally," but the catches were often "small" or no catch was made at all because the fish escaped from the net with the whale.

Because *Stenella* dolphins apparently are not systematically found accompanying tunas in the Atlantic, fishermen have not perfected techniques that would enable them to catch tuna associated with dolphins as U.S. vessels have. According to Maigret, it is "certain" that purse-seiners "sometimes" set on dolphins causing "much" mortality, but he provides no data in the report with which to quantify this statement. Figures showing areas of highest fishing concentration and locations of marine mammal sightings by month were extracted from the fishing records Maigret obtained from the FIS fleet(French/Ivoirian/Senegalese vessels) in 1976 and are presented in the report.

Dolphins have also been reported as being captured in the artisanal purse-seine fisheries along the west African coast which use pirogues (canoe-like boats). A purse-seine fishery for sardines occurs here involving pirogues from Dakar, M'Bour and Joal. Off the coast of Senegal in 1977, an average catch of two to three dolphins per month was thought to occur in M'Bour, the most important unloading point on the south coast. The animals are reported to be immediately cut up and eaten by the fishermen. Information is apparently hard to come by because the capture of cetaceans is illegal in Senegal. For more detailed information of the artisanal fisheries in this area see Maigret (1994) in this bibliography.

Maigret, J. 1981. Rapports Mammiferes Marins/Pêche dans l'Atlantique tropical. GEMMATA. No. 3:9.

From the information presented in Levenez *et al.* (1980) (see above), Maigret estimated that 3,300 dolphins are killed annually off the coast of west Africa based on a fleet of 42 seiners from France, 12 from the U.S., and 14 from Spain fishing off west Africa in 1977-1978.

EASTERN ATLANTIC

Coan, A.L. and G.T. Sakagawa. 1982. An examination of single set data for the U.S. tropical tuna purse-seine fleet. ICCAT, Coll. Vol. Sci. Papers. 18:83-94.

Single set data were collected from logbooks of U.S. seiners operating in the Atlantic between 1967 and 1980. Up to 1980, school fish sets (about 90%) dominated the annual catch statistics for the U.S. fleet, followed by flotsam sets (10%) and an occasional porpoise set or night set. Porpoise and night sets apparently are "rarely" made by the U.S. fleet operating in the eastern tropical Atlantic, with zero to three sets of these types being recorded in most years. The highest reported incidence of porpoise sets was in 1967 when 26 sets were recorded. Most of the sets were off the Liberian coast (location of sets are shown in the document). Porpoise and night sets were considered rare enough by the authors to warrant their exclusion from the rest of the analyses.

Pereira, J. 1985. Composition spécifique des bancs de thonidés pêches à la senne, aux Açores. ICCAT, Coll. Vol. Sci. Papers. 25:395-400.

Between 1982 and 1984, 110 successful sets by Portuguese purse-seiners operating near the Azores were observed. Birds were the index used "most often" in locating tuna schools. Pereira reports that the association with dolphins was also "frequent," but apparently the presence of dolphins in the net generally resulted in poor catches (16 metric tons (mt) caught in eight sets). In this sample, sets on dolphins represented 7.2% of all sets observed (8 out of 110).

Stretta, J.M. and M. Slepoukha. 1986. Analyse des facteurs biotiques et abiotiques associés aux bancs de thons. Pages 161-169 *in* P.E.K. Symons, P.M. Miyake, and G.T. Sakagawa, eds. Proceedings of the ICCAT Conference on the International Skipjack Year Program, Madrid, 1986.

Logbook data (from 1976 with no end date given) from purse-seiners of the FISM fleet were analyzed regarding sets made on tuna schools associated with marine animals, FADs and other aggregating objects such as carcasses or seiners. The data regarding cetaceans are summarized in the following table. "Positive" sets apparently refer to sets for which the catch tonnage was greater than zero.

	Type of Association:	Dolphin	Whale
Type of tuna school: Skipjack	positive sets:	9 (28%)	85 (79%)
	total sets:	32	108
Skipjack and yellowfin mixed	positive sets:	25 (93%)	248 (93%)
	total sets:	27	267
Yellowfin	positive sets:	47 (64%)	284 (65%)
	total sets:	74	440
Total	positive sets:	81 (61%)	617 (76%)
	total sets:	133	815

The total number of sets in the sample was 10,038. Sets on dolphins comprised 1.3% of all sets, while sets on whales represented 8.1% of the total. Although the numbers differ slightly, these data are from the same source as those used in Cayre *et al.* (1988) (see below) and are also found in Barrett (1991) (see below).

Cayre, P., J.B. Amon Kothias, T. Diouf and J.M. Stretta. 1988. Biologie des thons. Pages 157-268 *in* A. Fonteneau and J. Marcille, eds. Ressources, pêches et biologie des thonidés tropicaux de l'Atlantique Centre-Est. FAO Doc. Tech. Pêche 292.

These authors analyzed data collected between 1976 and 1982 from logbooks of tuna vessels belonging to the FIS fleet (French/Ivoirian/Senegalese fleet) and unloading at Abidjan. Trips included in the data set were selected based on how thoroughly the captain kept the logbook. The data set does not include unloadings in Dakar (27% of the catch in the period), therefore fishing in the northern area is poorly sampled. Of the catches made by the FIS fleet between 1976 and 1982, the sample includes 36.3% of the albacore catch, 38.1% of the skipjack catch, and 42.4% of the yellowfin catch. The following table from the text identifies sets made on free schools and on associated schools. "Positive" sets apparently refer to sets for which the tonnage of the catch was greater than zero. "Null" sets resulted in zero catch.

	Free Schools	Whale Sharks	Dolphins	Whales	Logs	Dead Animals	Tuna Boat	Total
Total sets	6,655	869	146 (1.4%)	856 (8.5%)	1,813	65	298	10,702
"Positive" sets	4,972	703	89	655	1,723	64	280	8,486
"Null" sets	1,683	166	57	201	90	1	18	2,216
% "Null" sets	25.29%	19.10%	39.04%	23.48%	4.96%	1.54%	6.04%	20.71%
% Total sets	62.18%	8.12%	1.36%	8.00%	16.94%	0.61%	2.78%	

Sets on dolphins represent 1.4% (34 sets) of all reported sets made on pure skipjack schools, 0.86% (30 sets) of all reported sets made on mixed schools of yellowfin and skipjack, and 1.76% (80 sets) of all reported sets made on pure yellowfin schools. Sets on whales comprise 4.48% (109 sets) of all sets made on pure skipjack schools, 7.45% (259 sets) of all reported sets made on mixed schools of yellowfin and skipjack, and 10.13% (460 sets) of all reported sets on pure yellowfin schools. The following table from the text lists the number of sets made on dolphins and whales by hydrological region. Catch per set data for each type of association is also included in the paper.

EASTERN ATLANTIC

Region	Sets on Dolphins (%)	Sets on Whales (%)
Senegal	20 (4.7%)	62 (14.5%)
Sherbro	49 (2.5%)	136 (7.1%)
Ghana	34 (2.1%)	159 (9.6%)
Cap Lopez	16 (0.4%)	274 (7.7%)
Equator	27 (0.9%)	218 (7.4%)

Arbex, J.C. 1990. Pescatores Espagnoles. Ministerio de Agricultura Pesca y Alimentacion. Secretaria General de Pesca Maritima, Madrid.

This book contains a photograph of fishermen alongside a seiner attempting to pull dolphins out of the net. The caption reads: "To release the dolphins trapped in the net with the tuna, the crew must hurl the dolphins out of the net into the open water. The presence of African fishermen is not unusual on board Spanish tuna vessels because of the written agreements between our countries." The following text accompanies the photograph: "The work of the fishermen does not end when the last tuna is brought on board. It is not unusual to find dolphins caught in the net and they are important to release because the marine mammals are very useful in detecting schools of tuna. The men do not hesitate to jump into the water to sink the yellow buoys of the net with their own weight in order to coax the dolphins to the open sea."

Bard, F.X. and A. Herve. 1990. Note sur le signalment de dauphins en association avec les thons tropicaux en Atlantique est. ICCAT, Working Document, SCRS/90/70. 8.

Scientific observers aboard French and Spanish purse-seiners operating out of Dakar and Abidjan recorded associations of tunas and dolphins during the International Skipjack Year Program (1981-1982) and the International Yellowfin Year Program (1986-1987). Information on 547 sets made during twenty fishing trips was collected. Observers apparently recorded data on sets involving marine mammals on two forms. The first form (G1) has a code indicating marine mammals were observed in association with a tuna school. On the second form (G2), observers indicated whether the set occurred with sharks, whale sharks or whales present in the purse-seine net, or whether a set simply involved marine mammals being associated in some other way with the tuna school. On neither form was there a specific code for the presence of dolphins during a set, which the authors attribute to the "rarity" of tuna-dolphin associations in the eastern tropical Atlantic.

From the G1 forms, tunas were associated with marine mammals 62 "times" with no indication of whether the association involved whales or dolphins. Observers recorded animals present in the purse-seine net on the G2 forms with the following frequencies: 722 sharks, 48 whale-sharks and 14 whales.

The authors obtained the observers' original forms for ten of the twenty trips covered (eight trips in 1981 and 1982, one trip in 1986 and one in 1987, all aboard French vessels). These originals indicated that when animals other than sharks, whale sharks, and whales were present in the purse-

seine net, their presence was recorded. These animals include, for example, turtles or marlins. However, if dolphins were in the net, their presence apparently was not recorded. In four cases when marine mammals were noted as being associated with tuna schools (as opposed to being present in the net) the animals involved were dolphins.

On the same forms, observers often mentioned sightings of dolphins which were not associated with tunas (an example of which occurred on 8 March 1981 when a school of dolphins estimated at 200-300 mt was sighted). In addition, questionnaires given to captains of French and Spanish purse-seiners at the end of 1989 noted that dolphins are "only rarely" caught in the net, although the schools of dolphins seen were said to be "quite dense and numerous."

In the conclusion of the paper, the authors note that the observer coverage, organized within the scope of the intensive skipjack and yellowfin programs of study, was not designed especially for the study of dolphin populations and their possible association with tropical tunas.

Pereira, J. 1990. Indices de détection et taille des thons dans les bancs associés à objets flottants. ICCAT, Coll. Vol. Sci. Papers. 35(1):192-195.

The author analyzed 1,903 sets using the logbooks of baitboats fishing near the Azores between 1983 and 1989. The most common index for locating tuna schools was birds (82.3% of all detections). Locating tuna schools using dolphins was less frequent (11 cases), even though dolphins were reported to be "very abundant" in the fishing areas. No detections involving live whales were recorded.

Santana, J.C., J. Ariz, P. Pallarés and A. Delgado de Molina. 1990. Nota sobre la presencia de mamíferos marinos en la pesquería de tunidos al cerco en la Atlantico este intertropical. ICCAT, Coll. Vol. Sci. Papers. 25: 196-198.

Data were collected from scientific observers on board purse-seining vessels in the eastern tropical Atlantic as part of the International Yellowfin Year Program. Observers were on board Spanish vessels during four cruises made between September 1986 and February 1987. Observers recorded 197 detections or sets (44 null sets, 67 successful sets, and 86 detections which did not result in sets). In only three cases were marine mammals the index used to locate the tuna school. A fin whale (*Balaenoptera physalus*) was sighted with an estimated 2 mt of skipjack weighing on average 1.5 kg and approximately 43 cm in forklength. In the other two cases, dolphins were the index of location. An estimated 13 mt of skipjack weighing on average 2 kg (46-47 cm forklength) were associated with one of the dolphin schools while no tunas were detected with the other. The tuna-dolphin association was set upon, but the fish escaped and the set was not successful.

On thirteen occasions, when detections were made, marine mammals were in the proximity. Only three of these detections resulted in sets. Apparently, in these three cases marine mammals were in the vicinity but not set upon. Of the remaining ten detections which did not result in sets, three involved baleen whales (species not identified), but they were not carrying any tuna. In the other seven detections, dolphins (species not identified) were present, but in only three cases were

tunas associated (1 mt yellowfin (50 kg approximate average weight and 140 cm forklength), 2 mt yellowfin of average size, and 5 mt of mixed species that actually may have been associated with a floating object in the vicinity).

A total of 67 sets yielded 1,327.2 mt of catch of which 48.5 mt were caught with marine mammals "in the proximity". On these cruises, the observers did not record any accidental entrapment of marine mammals. Tables in the paper present catch statistics for all sets by tuna species and for the three sets made with marine mammals in the proximity.

Barrett, I. 1991. Purse-seine sets on marine mammals. Memorandum to Gary Smith. Southwest Fisheries Science Center, 17 May 1991.

The memorandum contains the following table of percentages of marine mammal sets made by U.S. purse-seiners in the Atlantic Ocean, 1967-1980. Data were collected from logbooks completed by U.S. purse-seiners operating in the Atlantic Ocean. [These data are also reviewed in Coan and Sakagawa (1980) (see above), although the numbers differ slightly].

Year	Dolphin (sets)	Whale (sets)	Total sets
1967	10.1% (24)	1.7% (4)	237
1968	0.0%	6.6% (30)	454
1969	0.2% (4)	1.7% (30)	1728
1970	0.04% (1)	4.3% (98)	2258
1971	0.2% (3)	1.5% (27)	1769
1972	0.1% (4)	2.2% (80)	3546
1973	0.1% (1)	0.1% (13)	1503
1974	0.0%	3.1% (70)	2292
1975	0.2% (4)	1.2% (25)	2146
1976	0.2% (1)	2.0% (9)	454
1977	0.0%	0.5% (4)	8832
1978	0.1% (2)	4.0% (62)	1553
1979	0.0%	0.0%	572
1980	0.0%	15.9% (57)	358
Total	0.2% (44)	2.6% (509)	19,702

Barrett also cites data from Cayre *et al.* (1986) (see above) regarding sets on dolphins and whale made by the FISM fleet between 1976 and 1982.

Ariz, J., P. Pallarés, A. Delgado de Molina and J.C. Santana. 1991. Análisis de los datos obtenidos en campañas de observadores en el Atlantico intertropical durante el Programa Año del Rabil. ICCAT, Coll. Vol. Sci. Papers. 36:109-123.

Observers were placed on two Venezuelan purse-seiners in the western tropical Atlantic off Venezuela in November 1986 and in February 1988. In the eastern tropical Atlantic, six purse-seiners (four from the FIS fleet and two Spanish) carried observers between March 1986 and May 1987. Marine mammals were used 1.4% of the time in locating tuna schools. Tuna associated with dolphins comprised 6.8% of all associations. It is not clear if any sets were actually made on marine mammals or if the data regarding detections made using marine mammals and the data regarding tuna schools associated with marine mammals were gathered from sightings that did not involve sets.

Ariz, X., A. Delgado, A. Fonteneau, F. A. Gonzales Costas and P. Pallarés. 1992. Logs and tunas in the eastern tropical Atlantic. A review of present knowledges and uncertainties. Working Document for IATTC WG, La Jolla, February, 1992.

Logbook data used in this study were collected from purse-seiners of "all countries" operating out of Abidjan and Dakar between 1988 and 1991. The logbook data apparently represent an average of 87% of the total catches by purse-seiners in the area. The logbooks identify and code each individual set. These sets were subsequently recorded in a computer file. When floating objects, porpoise or whales are noted in the logbooks, these notes apparently are also recorded in the computer files (but only since 1988). Total catches by type of associations (in percentages) for the French and Spanish logbook data from 1988 to 1990 are presented in the text. An average of 8.6% of the total catch was made on "all other associations", which includes fishing on whales, whale sharks, dolphins, dead whales, the purse-seiner itself, "etc." The yearly percentages for this category are as follows: 8.4% in 1988, 8.4% in 1989, and 9.0% in 1990. The paper does not state the total number of sets this data sample encompassed.

The authors note, "the porpoise are very seldom noticed in the logbooks as being associated with the tuna schools, less than 0.2% of the catches. This percentage may be biased and lower than the real biological association, but it is a fact in the eastern Atlantic that none of the purse-seiners is equipped for fishing on porpoise, so this type of association and catch are probably a rare accident."

In Annex 1 of the paper, some scientific observations pertaining to floating objects encountered during the Yellowfin Year Program (ICCAT, 1986-1987) are given. On two occasions when floating objects were sighted, the comment "dolphins nearby" was recorded. The presence of skipjack tuna was recorded in one of these cases but in neither case was a set made on the floating object.

Nores, C., C. Pérez and J.A. Pis-Millán. 1992. Cetacean bycatches in the central Cantabrian Sea: Fishing gear selectivity. European Research on Cetaceans. No. 6. Proceedings of the Sixth Annual Conference of the European Cetacean Society, San Remo, Italy. 20-22 February 1992. p. 29. [Abstract]

Since 1977, the authors have recorded cetacean bycatches in the central Cantabrian Sea (otherwise known as the Bay of Biscay) through unloadings and strandings. Since 1983, they have improved their surveying of the five main fishing harbors of Asturias and have presented those data in this abstract. Forty-three catches involving 64 animals were recorded for the fishing fleet, which consists of less than 100 boats in this area (between 4° 31'W and 7° 02'W). The fishing nets used in this area include gillnets, shark longlines and purse-seines. Purse-seine nets are responsible for 11.5% of all animals caught. Four purse-seine sets resulted in dolphin bycatch (one involving *Phocoena phocoena* and three involving *Delphinus delphis*). The authors do not report the number of animals caught in purse-seine nets per incident or per species.

Maigret, J. 1994. Marine Mammals and fisheries along the west African coast. Rep. Int. Whal. Commn (Special Issue 15):307-316.

In his study, Maigret distinguishes three classes of fisheries that exist in west African coastal (Morocco to Angola) and pelagic waters: artisanal, local commercial and foreign. Artisanal fisheries use small boats (pirogues or canoes) and a variety of gear types including purse-seines. Local commercial fisheries which are considered national as opposed to foreign involve small boats operating under west African national flags and include purse-seiners primarily targeting tuna and pilchard. The foreign commercial purse-seine fishery targets tunas. Foreign commercial purse-seine vessels from the FIS and Spanish fleets, and occasionally vessels from the U.S. fleet, fish for tuna in the region, but they employ fishing techniques different from those in the eastern tropical Pacific because dolphins are apparently not used to locate tuna. Maigret adds, "consequently, the catches [of dolphins] in seines are much less dramatic." Populations of pelagic dolphins in this region include striped dolphins (*Stenella coeruleoalba*), spotted dolphins (*S. attenuata, S. frontalis*), clymene dolphins (*S. clymene*) and spinner dolphins (*S. longirostris*).

The report lists the number of national and foreign purse-seine vessels that operate in each country of the region. In most cases, artisanal fisheries are not broken down by gear type, but Maigret concludes that catches of cetaceans in artisanal seines are "rare." Those entries with relevant information are summarized below. Information on the number of boats operating in the fisheries is from 1988.

Morocco: A national purse-seine fishery for pilchard exists, but no quantitative information is available. Maigret surmises that "few" cetaceans are caught. In the national fishery for tuna, fishermen are replacing purse-seines with driftnets. There is no cetacean bycatch information.

Mauritania: The only vessels operating out of Mauritania that are known by the author to use purse-seine gear belong to foreign fleets. Two seiners and twenty tuna clippers (which use purse-seine gear (according to Maigret)) were operating out of Mauritania.

Senegal: Reported mortality of dolphins in purse-seines is found in Maigret (1981, see above). Maigret lists eight seiners (five tuna seiners) under national fisheries and 39 tuna seiners under the foreign fleet.

Cape Verde Islands: The industrial fleet consists of four foreign tuna boats that use lines, purse-seines and some driftnets. Ten national tuna boats also operate in these waters, but gear types are not specified.

Gambia: Coastal Ghanian purse-seiners operating in the Gulf of Guinea off Gambia decreased from seven in 1982 to three in 1988, but no information on cetacean-fishery interactions with these boats was presented. No other national purse-seine or tuna vessels were listed, but 40 foreign seiners (37 of them identified as tuna seiners) operated out of Gambia.

Guinea-Bissau: Eleven foreign tuna seiners fished out of this country, but apparently do not fish in Guinea-Bissau waters year round. Nothing is known of marine mammal fishery interactions.

Guinea: Forty-five foreign tuna seiners operate out of Guinea, but no information is available on interactions between this fishery and marine mammals.

Sierra Leone: The only purse-seine information presented for this country involves artisanal boats (pirogues) from Tombo of two types: traditional pirogues, 13-15m long with an outboard motor and a larger type, 15-20m long with a diesel engine. A total of 70 pirogues of these types fish for sardinella (*Sardinella maderensis*) and African ethmalosa (*Ethmalosa fimbriata*). Approximately 10,500 trips per year are made of four to eight hours each for a catch of about 8,000 mt (47% sardinella and 43% ethmalosa). "Porpoises" are "very infrequently (once or twice per year)" entangled in the center of the net and apparently die before being disentangled. The dead porpoises are then consumed locally.

Ivory Coast: The artisanal fishery includes 240 purse-seiners, but appears to involve "few" interactions with marine mammals. The local fishery has nineteen seiners and the number of foreign tuna seiners is unknown.

Ghana: Maigret reports that the pelagic fishery here is well-developed with pirogues and purse-seiners which probably cause "some" marine mammal mortality. In the local commercial fisheries of Ghana, there were 230 "trawlers/seiners" and 27 tuna seiners.

Equatorial Guinea, Sao Tome and Principe: Foreign tuna seiners are the only purse-seiners mentioned for these countries. In total, between 96 and 98 such vessels operate out of these countries.

Congo: Five local commercial seiners are based in this country.

Angola: Local commercial seiners total 120 vessels for this country. There are 23 foreign tuna seiners.

INDIAN OCEAN

Alling, A., J. Gordon, N. Rotton, and H. Whitehead. 1982. WWF-Netherlands Indian Ocean Sperm Whale Study, 1981-1982, Interim Report. IWC, Working Paper. IWC/SC/34Sp. 9.

The authors report on incidental sightings of small cetaceans made during a sperm whale cruise in the northwestern Indian Ocean. Six sightings of *Stenella longirostris* off Sri Lanka, India and Oman are described in the text. Local fisheries involving marine mammals in Djibouti, Oman, and Sri Lanka are also described. According to local fishermen, *S. longirostris* is incidentally caught in the fisheries for yellowfin, bonita and skipjack. The authors speculate that the problem may be analogous to the incidental catch of dolphins in purse-seines in the Pacific, but it is not clear which gear types the tuna fishermen are using.

Marsac, F. 1983. Radiometrie aerienne et prospection thoniere aux Seychelles. Mission ORSTOM aux Seychelles. Rapp. Sci. No.2. 82.

In November 1981, a research program conducted aerial surveys using infrared equipment to evaluate tuna resources in the Seychelles. The aerial surveys were carried out during the north-west monsoon period (November to March) and the south-east monsoon (October) period for 250 flight hours during each climatic period. Sightings are summarized for each time period when flights occurred. There are maps indicating the locations of sightings of tuna, dolphin, and bird schools, and whales for each time period. There is no tabular summary of these sightings, but I have counted the number of tuna and dolphin schools on each map to ascertain the ratio of dolphin-associated tuna schools to the total tuna schools sighted. Of the 155 tuna schools sighted, five (3.2%) appear to be tuna-dolphin associations. Two of these associations consist of dolphin-skipjack, one of dolphin-yellowfin, and two of dolphins with mixed tuna species. Sightings of baleen whales in "immediate proximity" to tuna schools are mentioned in the text, yet distances on the maps between baleen whale codes and tuna school codes are sometimes just as small as those between some dolphin school codes and tuna school codes. In other words, lacking a precise definition of "immediate proximity" from the authors, dolphins schools appear to occur in "immediate proximity" to tuna schools just as often, if not more so, than baleen whales.

Marsac, F., B. Piton, M. Potier and B. Stéquert. 1983. Campagne expérimentale de pêche à la senne du thonier "Yves de Kerguelen" dans l'ouest de l'ocean Indien tropical. Mission ORSTROM aux Seychelles. Rapp. Sci. No. 3. 112.

This report covers exploratory French purse-seine fishing conducted primarily in the Exclusive Economic Zone (EEZ) of Seychelles and the surrounding area between November 1981 and July 1982. Most of the data are analyzed by period according to the monsoons in the following manner: the northwest monsoon period extended from November 1981 to mid-March 1982, the inter-monsoon was from mid-March 1982 to mid-May 1982 and the southeast monsoon lasted from mid-May 1982 to July 1982.

Tuna schools associated with birds comprised the "majority" of reported associations, whereas associations between tunas and marine mammals were "much less frequent." During the northwest monsoon, 5% of all reported associations involved tunas with marine mammals. Tuna-marine mammal associations totaled 8% of observations during the inter-monsoon. No marine mammal associations were observed during the southeast monsoon. Associations with birds ranged from 75% to 83% of the total during the three periods, while associations with floating objects occurred 16% to 17% of the time. Non-associated tunas comprised 0% to 2% of the total.

During 137 days of fishing, the vessel made 97 sets of which 70 (72%) were successful. Total catch reached 1,370 mt (720 mt on schools associated with floating objects and 650 mt on school fish which, in this case, refers to all other associations as well as to strictly non-associated tuna schools). Data on sets and catch by type of association are not given. During the northwest monsoon 41% of the catch was pure yellowfin schools, 19% pure skipjack schools and 40% mixed tuna schools. The inter-monsoon and the southeast monsoon periods caught more skipjack schools (47% to 54%) than yellowfin schools (37%). The report includes figures of the vessel's cruise tracks, locations of sets and forklengths of tunas caught by monsoon period and by sectors fished.

Leatherwood, S., C.B. Peters, R. Santerre, M. Santerre and J.T. Clarke. 1984. Observations of cetaceans in the Northern Indian Ocean Sanctuary, November 1980-May 1983. Rep. Int. Whal. Commn. 34:509-520.

Information on cetacean observations in the Northern Indian Ocean Sanctuary is summarized from the following surveys: shipboard observations and interviews from Djakarta to Seychelles, 1 to 27 April 1983; boat observations and interviews from Maldives and Sri Lanka, November 1980 to January 1983; boat observations off northeastern Sri Lanka on 28 February 1983; aerial observations off northwestern Sri Lanka on 4 March 1983.

Shipboard sightings of spotted dolphins (*Stenella attenuata*) occurred six times between 1 and 27 April (4,023 km of survey track covered) for a total of 473 dolphins with a mean school size of 79. Seven sightings of spinner dolphins (*S. longirostris*) (497 animals, mean school size=71), three sightings of common dolphins (*Delphinus delphis*) (87 total animals, mean school size=29) and one sighting of 100 striped dolphins (*S. coeruleoalba*) occurred during the same cruise. An association of 200-250 spotted dolphins with 150 Risso's dolphins (*Grampus griseus*) and 25-30 false killer whales, (*Pseudorca crassidens*) were sighted northeast of Sri Lanka. The cetaceans were accompanied by numerous birds and apparently a school of large fish.

Information obtained from interviews indicates that spinner dolphins are frequently seen north of Aride Island towards the shelf edge. They are "often" found beneath concentrations of birds and local fishermen apparently take tuna from such feeding aggregations.

During fisheries enhancement research surveys off the Maldives and Sri Lanka, spinner dolphins in schools of approximately 500 animals were sighted "often". Off southwestern Sri Lanka, spinner dolphins were seen "frequently" around FADs and other fishing activity usually in waters deeper than 500 m. Sightings of spotted dolphins also occurred during these surveys.

Two sightings of spinner dolphins (school size = 275-300 and 100) occurred during aerial surveys off western Sri Lanka in waters 100m deep along the shelf. A school of fish of undetermined species and approximately one acre in size accompanied the larger group of spinner dolphins.

Potier, M. and F. Marsac. 1984. Pêche thonière dans l'Ocean Indien: Campagne exploratoire d'une flotille de senneurs (1982-1983). Mission ORSTROM aux Seychelles. Rapp. Sci. No. 4. 88.

Between December 1982 and November 1983, six purse-seiners participated in an exploratory fishing campaign in the Indian Ocean. Of the 744 sets made during the campaign, 340 involved "free swimming schools" and comprised 31% of the total catch. The percentage of "successful" sets was 44% and catch per "successful" set was 26 mt. Only one school was considered a strictly non-associated tuna school. The remaining 339 were reported to be associated with birds or marine mammals, and of these, associations with birds were most numerous.

The following percentages are calculated using the total number of sets (744) so they include the 404 schools set upon that were associated with floating objects. Associations with baleen whales represent 10% of all associations during the northwest monsoon and 4% during the inter-monsoon. Two percent of all associations during the northwest monsoon and 1% during the inter-monsoon consisted of tunas associated with small cetaceans. Catch composition statistics are given by period (northwest monsoon, inter-monsoon and southeast monsoon), but there is no information on catch by association type.

Alling, A. 1985. Incidental records of small cetaceans in the northern Indian Ocean (1981-1982) and off the coast of Sri Lanka (1982-1984). Paper submitted to Int. Whal. Comm. 36, 1986 SC/37/SM4.

A cetacean survey was conducted between 29 November 1981 and 12 February 1982 in the northwest portion of the Indian Ocean. The author reported that a large fish, possibly a tuna, was seen jumping out of the water in the middle of a school of spinners. A mixed school of spinner and spotted dolphins was followed for forty minutes and tuna were seen jumping out of the water among the dolphins.

Marsac, F and J.P. Hallier. 1985. Environment et pêche thonière de surface dans l'ocean Indien occidental (1983-1984). Antenne ORSTROM aux Seychelles. Rapp. Sci. No. 5. 98.

This report examines the logbook data from French and Ivoirian seiners operating in the western Indian Ocean between November 1983 and December 1984. Observations made by biologists on board are also included, although the degree of coverage that these observations

represent is not clear. Tuna schools associated with large cetaceans, in particular baleen whales, in addition to schools not associated with other animals, are collectively referred to as "free swimming schools." The most common tuna-whale association encountered involves fin whales (*Balaenoptera physalus*). The authors note that the association between tunas and dolphins is "very rare" in this region.

A total of 4,936 sets were used in the analyses (1,184 sets on floating objects and 3,752 sets on "free swimming schools"). Total catch from sets made on whales was 8,978 mt with an average of 16.4 mt caught per set. The rate of successful sets was 75% with 22.1 mt caught per successful set. The composition of catches made on floating objects included 6,402 mt of yellowfin and 22,866 mt of skipjack. Catches made on free swimming schools consisted of 36,251 mt of yellowfin and 8,835 mt of skipjack.

Stéquert, B. 1986. Prospections thonières de surface menées par les Japonais dans l'ocean Indien. La Pêche Maritime. 1302:646-651.

The Japan Marine Fisheries Resource Center (JARMAC) conducted a series of exploratory purse-seine cruises in the Indian Ocean between 1979 and 1985. During two trips between November 1982 and March 1983, the *Nippon-Maru* encountered five tuna schools that were associated with "whales, sharks, or dolphins." These schools represent 3.8% of all observations made. Of the 47 sets made, all involved floating objects.

Stéquert, B. and F. Marsac. 1986. La pêche de surface des thonidés tropicaux dans l'ocean Indien. FAO Doc. Tech. Pêches, 282. 213.

The authors report on artisanal and commercial surface fisheries in the Indian Ocean by country. The artisanal fisheries involve purse-seining primarily for tunas, although some target sardines and mackerel (fishery information by gear type was not presented for several countries in the region):

India: Purse-seining occurs on the west coast, primarily in the districts of Goa, Mangalore and Cochin. Seines are 400-800 m long with a 40-60 m drop. The boats are 14-15 m long and the trips occur daily. Tuna are not among the target species which are sardines and mackerel in this fishery. When this report was written, 350 seiners were fishing along the Kerala and Kanataka coasts.

Indonesia: North of Sumatra, purse-seines comprise the principal fishing gear. Boats are 18-20 m long with nets 700-1200 m long and 40-60 m deep. Trips are daily and the catch varies between skipjack, yellowfin, and some smaller tunas. In 1982, 240 seiners operated in this area.

Thailand: Purse-seining off Thailand is carried out by 20-100 t boats (most in the 20-50 t range) which target tuna. In 1980, purse-seiners especially equipped for catching tuna (sonar, large mesh nets) made their appearance in this area with nets 800-1600 m long and 70-140 m deep. Trips last four to five days for smaller vessels and eight to ten days for the larger ones. Catch for these vessels totaled approximately 2,000 mt between 1971 and 1981. Previous to 1979, fishing consisted of

traditional Thai or Chinese seine nets which did not involve the use of FADs. Once FADs were introduced fishing effort and catches increased (average catch for 1982 and 1983 was 6,500 mt). In 1982, 61.7% of the total catch was caught using FADs.

The authors also use data from the French and Ivoirian commercial fleets found in Marsac *et al.* (1983), Potier and Marsac (1984) and Marsac and Hallier (1985) (all reviewed separately in this bibliography) to compare catches made on FADs to catches made on free-swimming schools, a category which usually includes any tuna-marine mammal associations. From these reports the authors reiterate that the tuna-dolphin association is "rare" in the Indian Ocean.

Montaudouin, X. de; J.P. Hallier and S. Hassani. 1990. Analyse des données collectées lors des embarquements à bord des senneurs basés aux Seychelles (1986-1989). SFA Tech. Rep., SFA/R&D/014. 34.

The tuna purse-seine fishery based in Seychelles is analyzed using data collected by observers aboard French, Spanish, Japanese and Soviet vessels between 1986 and 1989. The effort for each year is as follows:

1986: 230 days of coverage (95% from French vessels, 5% from Spanish vessels)
1987: 367 days of coverage (84% from French vessels, 12% from Spanish vessels and 4% from Japanese vessels)
1988: 486 days of coverage (39% from French vessels, 26% from Spanish vessels, 36% from Japanese vessels)
1989: 738 days of coverage (27% from French vessels, 33% from Spanish vessels and 40% from Japanese vessels)

The data collected over 167 days aboard the Soviet vessels were not used in the comparisons because their method of fishing "differed from that of the other nations." The majority of sets involved tuna-bird associations (89% of all sets in 1986, 85% in 1987, 72% in 1988 and 82% in 1989). Associations between tunas and small cetaceans are said to be "practically non-existent. " There were no sets on small cetaceans reported for 1986, 1987 or 1988. In 1989, 8 sets (2.0%) were made on tuna associated with small cetaceans. Two of these sets were successful (0.7% of all "successful" sets) and represent 0.4% (31 mt) of the total catch. Sets on baleen whales and sperm whales were also recorded. "Successful" sets apparently refer to sets for which the catch tonnage was greater than zero.

	Year	Number of sets (% of total sets)	Number of successful sets (% of successful sets)	% of total catch (catch in mt)
Baleen whales	1986:	7 (5.0%)	4 (5.0%)	5.4% (134 mt)
	1987:	15 (5.3%)	9 (4.9%)	5.8% (309 mt)
	1988:	20 (4.5%)	15 (5.2%)	4.8% (494 mt)
	1989:	7 (1.7%)	4 (1.3%)	1.7% (142 mt)
Sperm whales	1986:	0 (0.0%)	0 (0.0%)	0.0%
	1987:	0 (0.0%)	0 (0.0%)	0.0%
	1988:	17 (3.9%)	7 (2.4%)	1.6% (168 mt)
	1989:	0 (0.0%)	0 (0.0%)	0.0%

Sudara, S. 1990. Dolphins in Thailand. IWC Working Paper, Symposium of Incidental Mortality of Marine Mammals in Passive Fishing Nets and Traps, Working Paper SC/090/G32. 3.

Sudara reports that local fisherman using small boats equipped with purse-seines said they use dolphins to locate fish schools such as skipjack. Apparently, the dolphins usually cause the fishermen trouble because they get entangled in the net and drown. Sudara reports that some fishermen shoot the trapped dolphins to prevent them from damaging the nets. Previously, fishermen would attempt to release captured dolphins because they believed dolphins helped save the lives of fishermen who fell overboard. However, according to the author, the fishermen now resort to shooting dolphins who approach the net or are entangled in the net. Sudara lists four species that reportedly occur in Thai waters, both in the Gulf of Thailand aand in the Andaman Sea: *Delphinus delphis*, *Tursiops aduncus*, *Orcaella brevirostris* and *Stenella malayana* (this taxonomic designation is uncertain.

de Silva, J. and Boniface, B. 1991. The study of the handline fishery on the west coast of Sri Lanka with special reference to the use of dolphin for locating yellowfin tuna (*Thunnus albacares*). IPTP (FAO). Coll. Vol. Work. Doc. Vol 4. TWS/90/18.

A tuna fishery off Beruwela on the west coast of Sri Lanka consists of 3.5 ton multi-gear boats which account for 90% of tuna landings in this area. The gears used include handlines, gillnets, surface troll lines, and bottom lines. Boats that use a combination of handlines and troll lines have an observation platform attached to the mast, which the crew uses to spot dolphins. When dolphins are sighted, the fishermen apparently pursue the dolphins in hopes of catching any yellowfin tuna that are associated with them. According to the fishermen, the tuna caught in association with these dolphins include the larger sized yellowfin (100 cm and above). This study, which began in October 1987, presents information gathered from interviews with sixty fishermen and data collected during seven months of monitoring three boats that used this method of fishing.

Of those interviewed, forty fishermen responded that they had noted one association of yellowfin tuna with spinner dolphins (*S. longirostris*), 18 with spotted dolphins (*S. attenuata*) and 2 with striped dolphins (*S. coeruleoalba*). The fishermen interviewed believe the dolphins follow

the tuna in order to "lick" the mucus that covers the tuna. These fishermen believed the chance of finding a school of yellowfin was "very high" if spinner dolphins (*S. longirostris*) were sighted.

During the seven months of monitoring, the three boats made 31 trips. Dolphins were sighted on 27 occasions and yellowfin tuna were caught on 23 of these occasions. Of the sightings, 23 involved spinner dolphins (*S. longirostris*) and three involved spotted dolphin (*S. attenuata*) sightings. The species of dolphin involved in the one remaining set is not given.

Sabadach, B. and J.P. Hallier. 1993. Analyse des donneés collecteés lors des embarquements à bord des senneurs basés aux Seychelles (1986-1991). SFA Tech. Rep., SFA/R&D/024. 44.

This report analyses data collected from Seychelles Fishing Authority (SFA) observers on board tuna purse-seiners based in the Seychelles. The data presented in this report include data published in earlier reports (e.g. Karpinski, 1988) because those analyses did not include data from the Soviet vessels and were done prior to important data verification and correction work performed on the complete database.

Observer coverage of the four fleets involved averaged 2.69% for the Spanish fleet, 4.50% for the French fleet, 30.44% for the Japanese fleet and 5.89% for the Soviet fleet. Coverage varied significantly from year to year in most cases. Four observers were employed by SFA between 1986 and 1989, after which only two observers were used.

For indicating types of associations, a code for small cetaceans was included on observers' data forms, but no sets made in the presence of small cetaceans were recorded. Baleen whales and whale sharks were also "rarely" seen, although 111 sets (4.7%) were made on whales. Sixty-eight (4.2%) of these sets were successful and caught 1,990 mt of tuna.

Eyre, E. J. 1995. Observations of cetaceans in the Indian Ocean Whale Sanctuary, May-July 1993. Rep. Int. Whal. Commn 45:419-426.

Greenpeace conducted a cetacean sighting survey in the Indian Ocean Sanctuary during the 1993 austral autumn and winter. The survey lasted 45 days and covered 9,165 nautical miles. Details of the survey effort are in the text of the report. Observers recorded 16 sightings of spinner dolphins (approximately 292 individuals), and three sightings each of spotted and common dolphins (approximately 51 and 74 individuals, respectively). Blue whales were seen in direct association with tuna WNW of Seychelles. One area where cetacean sightings were reported to be "numerous" was in the tuna purse-seine grounds west of Seychelles. The author reported that large schools of fish, particularly tuna, and seabirds occurred in the same locality of blue, sperm, Bryde's and killer whales and spinner dolphins. Tuna were sighted with and without associated cetaceans, but the author does not present details of these sightings. The observers reported "elusive" behavior on the part of cetaceans, especially spinner dolphins and killer whales within the French purse-seine fishing grounds.

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Ohsumi, S. 1972. Catch of marine mammals, mainly of small cetaceans, by local fisheries along the coast of Japan. Far Seas Fish. Res. Lab. Bulletin 7, November 1972. 137-166.

Ohsumi reviews the catch statistics published in the Annual Reports of the Statistics and Survey Division of the Ministry of Agriculture and Forestry, Japan from 1957 to 1968 for local fisheries along the coast of Japan (Fig. 4). Incidental catches of dolphins in purse-seine nets (primarily in two boat operations) totaled 1,744 tons for this period (8.04% of all direct and incidental catches). If one excludes direct catches by harpoon and drive fisheries and considers only fisheries in which catches of dolphins are classified as incidental by the authors, the purse-seine fishery accounts for 50% of this mortality. The target species of the purse-seine fisheries are not given.

Between 1957 and 1962, one ton of marine mammals were captured in single-boat purse-seine operations all of which took place in The "Pacific, North" region which extends from Aomori Prefecture to Ibaragi Prefecture along the Pacific coast. Relative abundances are given for each species by region. Marine mammal mortality by species is not provided. The author notes, however, that in the "Pacific, North" region right whale dolphins and Pacific white-sided dolphins are caught incidentally by the purse-seine fishery in that region.

Anon. 1974. *Sea Treasure* cruise. 15 October to 10 December 1974. Pacific Tuna Development Foundation Report. 29.

The Pacific Tuna Development Foundation chartered the M/V *Sea Treasure* to test the ability of their purse-seine gear to capture fast, erratic surface tuna schools in the central, western and southwestern Pacific (Fig. 3). The charter area comprised the waters around French Polynesia. The tuna schools sighted were "few and small." The crew sighted flocks of birds "frequently," but "rarely" were there tunas associated except for a few small, loose aggregations of skipjack. Bottlenose dolphins (*Tursiops truncatus*), spotted dolphins (*S. attenuata*), and spinner *dolphins(S. longirostris*) and false killer whales (*Pseudorca crassidens*) were seen but none were carrying tuna.

Bannister, J.L. 1977. Incidental catches of small cetacea off Australia. Rep. Int. Whal. Commn. 27:25.

Bannister notes, "unlike the U.S.A. situation, Australian purse-seining activities are not associated with the location of dolphin-fish groups so consequential dolphin kills do not occur."

Anon. 1977. Pacific Tuna Development Foundation. Final Report. Tuna purse-seine charter to the western Pacific, July-November, 1976. Apollo, Mary Elizabeth, and Zapata Pathfinder. 47.

During the charter, 286 tuna sightings were made during 170 days of effort aboard the purse-seine vessels *Apollo*, *Mary Elizabeth* and *Zapata Pathfinder*. Fifty-eight of the sightings were school fish, 4% were marine mammal associated and 38% were log associated. Tunas associated with marine mammals were sighted ten times, most sightings consisted of whales. Tunas were "rarely" observed in association with porpoise.

Six tuna schools associated with whales were set upon, but none of these sets were "successful." Either the tuna would evade the net by leaving the whale or the tuna were led out of the seine by the whale before encirclement was complete. Table 6 of the report indicates no sets on dolphins were made within the PTDF charter area. However, in the summary of all sets made by the three vessels between July and October, 1976 (Table 10 of the report), the Apollo made one set on dolphins catching five tons of tuna. This set may have taken place just outside of the pre-determined charter area (the position of the set is given, but the exact borders of the charter area are not clearly shown), and, therefore, may not have been included in Table 6. A total of 82 sets were made (42 of them successful) with 59% on logs, 34% on school fish, and the remaining 7% on whales.

In the charter area, spotted, spinner, and common dolphins were spotted along with a few unidentified species. The whales observed were sei, minke, and an unidentified whale. Tuna were associated with 22% of all marine mammal sightings (eight out of ten whale sightings had tuna associated and two out of 36 dolphin sightings had tuna associated). The tuna observed with whales were said to be mostly yellowfin.

Further information on charter area, location of sets, catches (tonnage, length frequencies by species, etc.) and estimated tons of tuna per free school sighted and per associated school sighted is provided in the text.

Honma, M. and Z. Suzuki. 1978. Japanese tuna purse-seine fishery in the western Pacific. Far Seas Fish. Res. Lab. No. 10, S series. 66. [In Japanese]

The authors reviewed catch and effort statistics and length and weight data from the Japanese purse-seine fleet in the western Pacific (Fig. 3) for the years 1968 to 1974. Between October 1971 and March 1972, eight sets on tuna schools associated with whales or whale sharks were made and caught 44 tons of tuna. Between October 1972 and March 1973, fourteen sets were made on whale or whale shark associated tuna schools for a catch of 102.8 tons of tuna. Because the majority of the paper is in Japanese, the information summarized here is limited to the portions of the text which were presented in English.

Souter, D. and G. Broadhead. 1978. Purse-seine fishing for yellowfin and skipjack in the southern waters of the central and western Pacific, *Jeanette C.* charter. Pacific Tuna Development Foundation. Technical Bulletin 2. 77.

A purse-seine vessel was chartered to fish for tuna in the southwestern Pacific (Fig. 3) from 7 August 1977 to 30 April 1978. No sets were made on tuna-dolphin associations. Although several dolphin schools were sighted, none were associated with "good tuna schools." Regarding dolphin schools listed in the cetacean sighting appendix, no mention of any associated tuna occurs. Whale sightings were "common" and one set was made in an area where sperm whales and yellowfin tuna were feeding. Of all the tuna schools encountered, 90% were located through bird sightings. Of the 114 total sets made, 51.8% were on logs and 48.2% on school fish.

Anon. 1979. Tuna purse-seining cruise report, July 1978 - February 1979, *Bold Venture*. Pacific Tuna Development Foundation Report. 35.

The purse-seine vessel *Bold Venture* was chartered for eight months to fish in waters north and northwest of Papau New Guinea (Fig. 3). Dolphins schools and whales were seen and recorded, although apparently not pursued. No associations between these animals and tuna were sighted or set upon. Most of the tuna schools were located as a result of bird sightings. A total of 51 sets were made, 73% on logs and the remainder on school fish.

Burns, F. and D. Souter. 1980. Tuna purse-seining cruise report, June-August 1980, *White Star*. Report by Living Marine Resources, Inc. 29.

The purse-seiner *White Star* surveyed and fished a portion of the Pacific Ocean west of Hawaii and a second area further south between June and August of 1980. A total of 29 sets were made, 7 on logs and the remaining 22 on school fish. School fish sets comprised 94% of the catch. In the first area surveyed, 11 sightings of marine mammals occurred, but none involved any associated tuna.

In the second region, 21 sightings of marine mammals were made. A total of 7 (33%) marine mammal sightings involved associated tuna or tuna schools in the vicinity. Groups of one to two minke whales were sighted on five occasions, and on each occasion tuna were associated with the whale(s). Two of the associated schools consisted of skipjack, two of yellowfin. The species of tuna involved in the fifth case was not identified. The sixth sighting involved an unidentified marine mammal sighted in the vicinity of several tuna schools. Lastly, an unidentified whale was sighted and set upon in the midst of a yellowfin school. No further information is provided regarding this set. No dolphin schools were noted as being associated with tuna.

Salomons, R. and D. Souter. 1980. Tuna purse-seining, *Island Princess* Cruise Report, June to October, 1979. Report prepared for the Pacific Tuna Development Foundation by Living Marine Resources.

The purse-seine vessel *Island Princess* fished in the western Pacific (Fig. 3) between 17 June and 27 October 1979. Bird flocks and flotsam (logs) were the major cues used to locate tuna schools. Numerous marine mammals were encountered during the charter. The text states that none of the marine mammals sighted had associated tuna. However, the appendix of set summary details lists two sets that were made on whales. In one case, a breezer of skipjack were associated with one whale (species not given). The second whale set involved a foamer (species not given for the whale or the associated tuna). Although these sets were made on whales they are recorded as "school fish" sets. Two additional sightings of whales occurred later in the trip in which scattered tuna were seen around one whale and a school of skipjack were feeding near the second whale.

Between August and mid-October, spotted dolphins (*S. attenuata)* were sighted eleven times with school sizes ranging from 15 to 1,000+ (mean school size = 223). The presence of fish was not noted for any of these sightings. Spinner dolphins (*S. longirostris*) were sighted five times with school size ranging from 30 to 1,000 (mean school size = 436). The presence of fish was not noted

for any of these sightings either. *Grampus griseus*, *Orcinus orca*, *Globicephala* sp., *Physeter macrocephalus*, and unidentified porpoise and whales were also sighted. Of the seven sightings of unidentified whales, one whale had scattered tuna around it and another was seen feeding near a school of skipjack.

Souter, D. and R. Salomons. 1980. Tuna purse-seining, cruise report, June-September 1980, *Island Princess*. Report by Living Marine Resources, Inc. 48.

In 1980, the *Island Princess* made 71 sets during 76 searching/fishing days in the western Pacific (Fig. 3). Twenty-seven sets were "successful" (catching one ton or more), nine of which were log sets and eighteen of which were made on school fish. The percentage of catch made on school fish was 83.5%. The total catch consisted of 97% skipjack and 2% yellowfin. No tuna-dolphin associations were encountered. Several dolphins schools, mainly spinners, and large cetaceans were sighted and are described in the marine mammal sighting appendix of the report.

Souter, D. and R. Salomons. 1980. Tuna purse-seining, cruise report, *Jeanette C.*, May-September, 1979. Report prepared for the Pacific Tuna Development Foundation by Living Marine Resources, San Diego, California.

The purse-seine vessel *Jeanette C.* fished in the waters northwest of Hawaii and in the North Pacific between 7 May and 18 September 1979. Several dolphin schools and whales were sighted and recorded. The text states that no tuna were seen in association with marine mammals. However, in the marine mammal sighting appendix, large yellowfin tuna were noted in association with an unidentified whale. In addition, a school of 150-200 spotted dolphins was seen with "shiners" under it. Thirty-seven sets were made with 59% on logs and the remainder on school fish.

Bailey, K. and D. Souter. 1982. Tuna purse-seine cruise report, June 2 - August 10, 1982, M/V *Western Pacific*. Final Report. Pacific Tuna Development Foundation. 37.

During 65 searching/fishing days in the western Pacific (Fig. 3), the charter made 27 sets (14 were "successful," with six sets made on logs and eight sets made on school fish). Total catch was 572 tons of tuna, 86.7% of which was caught on school fish sets. Yellowfin tuna comprised 56.5% of the total catch while 43.5% of the catch was skipjack. Large schools of dolphins were observed, but none were associated with tuna. The vessel sighted a school of at least 250 spinner dolphins and circled them for 20 minutes to observe their behavior. The dolphins were "effectively trapped" by the vessel's wake, but no tuna were seen accompanying them. Sei whales were observed feeding among schools of skipjack and yellowfin on two occasions, but sets were not made on these aggregations.

Anon. 1982. New Zealand. Progress report on cetacean research, May 1980 to May 1981. Rep. Int. Whal. Commn. 32:189-195.

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Eleven cetaceans were reported to be incidentally taken in tuna purse-seine nets in New Zealand waters (Fig. 3) for 1980-1981. The only cetacean species involved were common dolphins (*D. delphis*). Two incidents accounted for all the mortality. The progress report provides the date, location, and the number of animals killed in each incident.

The New Zealand tuna purse-seine fishery targets skipjack, which is not thought to form an association with common dolphins in New Zealand Waters. During the 1980-1981 season, tuna seiners in this fishery made 800 sets (incidental catches of cetaceans occurred in 1% of these sets). This mortality information is also found in Anon. (1994) (see below), but the numbers are slightly different.

Miyazaki, N. 1983. Catch statistics of small cetaceans taken in Japanese waters. Rep. Int. Whal. Commn. 33:621-631.

Miyazaki reviews catch records of 14 species which were collected by the Japanese Fisheries Agency, and later by JAMARC, for the six year period 1976-1981. The catch records resulted from a questionnaire survey of the Japanese fishermen's unions. Sixty small cetaceans were reported caught in purse-seine nets in Japanese waters (Fig. 4), five *Globicephala macrorhynchus* and 55 *Lagenorhynchus obliquidens*.

Lambert, J.F. 1984. Tuna purse-seine cruise report, July 21-November 9, 1983, M/V *Jo Ann*. Final Report. Report prepared by Living Marine Resources for Pacific Tuna Development Foundation. 38.

The purse-seine vessel *Jo Ann* surveyed and fished the waters of the Northwest Hawaiian Islands and the Line Islands between 21 July and 9 November 1983. During the Northwest Hawaiian Islands leg of the survey, 15 sets were made, 11 on logs and 4 on school fish. Only 7 sets (6 log, 1 school fish) were "successful," meaning the catch was one ton or greater. Of the total catch, 97.8% was caught in log sets. No marine mammals sets occurred although logs of marine mammal sightings were kept. Marine mammals were sighted in association with tuna on three occasions: small yellowfin and skipjack jumpers seen with a 30 ft baleen whale, another 30 ft baleen whale seen feeding on the edge of a school of tuna, and a 15-20 ft baleen whale seen feeding in the midst of a "1-pole" yellowfin school. A school of 30-75 rough-toothed dolphins *(Steno bredanensis*) were sighted in the vicinity of several 60 ton schools of yellowfin. The dolphins were sighted just prior to a school fish set made on a breezer but apparently were not involved in the set itself.

Patterson, P. and F. Alverson. 1986. Summary of spotted, spinner, unidentified and other identified porpoise sightings reported by commercial tuna vessels fishing in the tropical central and western Pacific Ocean. National Marine Fisheries Service, Southwest Fisheries Science Center, Admin. Rep. LJ-86-06C. 25.

A tuna fishery developed in the central and western Pacific Ocean (Fig. 3) in the early 1980's attracting several vessels which had formerly fished in the eastern tropical Pacific. In 1981, the Pacific Tuna Development Foundation (PTDF) staff requested the skippers record marine mammal sightings while fishing in this area. PTDF asked the skippers especially to note sightings of spotted

(*S. attenuata*), spinner (*S. longirostris*), striped (*S. coeruleoalba*), and common dolphins (*D. delphis*). The information was recorded in the bridge logs and later processed by the research firm Living Marine Resources (LMR). According to the authors, such voluntary recording of marine mammal sightings in an area where the fishery "does not involve dolphins" resulted in only a few skippers taking the time to record these sightings. Interviews with the skippers (presumably conducted by the authors) indicated that dolphins were "commonly" seen in the fishing area but were "seldom" recorded.

Between 1981 and 1984, 632 fishing trips were made in the central and western Pacific for which LMR processed 463 logbooks. However, when this report was published, LMR had "recovered" data from only five fishing trips made by three vessels. Of the eleven spotted dolphin schools recorded, the comments indicated one school had no fish associated, and the presence or absence of fish was not mentioned for the remaining ten schools. Information gathered during the interviews revealed that a mixed school of spotted and spinner dolphins sighted three days southwest of Hawaii had a "large spot" of fish on the sonar which were thought to be "three-pole jumpers." Six schools of spinner dolphins were recorded with one school identified as having no fish and the remaining five schools having no mention of whether fish were associated or not. Of the eleven schools of "other identified" and unidentified dolphins recorded, none were mentioned as having fish associated or not. However, interviews with skippers indicated that several large schools of dolphins were seen carrying "a good body" of tuna in the vicinity of Truk Island.

Dolar, M.L.L. 1990. Incidental takes of small cetaceans in fisheries in Palawan, central Visayas and northern Mindanao in the Philippines. Rep. Int. Whal. Commn (Special Issue 15). 355-363. SC/O90/G29.

Purse-seining in this region (Fig. 5) includes small municipal boats which primarily set on FADs within and outside of 7 km of shore. In addition, large commercial vessels, which primarily set on free-swimming schools, fish more than 7 km offshore. The author obtained information during trips on fishing vessels, visits to fish markets, and interviews with crew members and owners of commercial and municipal fishing vessels, local fishermen, market vendors, and middlemen. Information was collected in Basay and Malabuhan in Negros, Pamilacan Island in Bohol, Brooke's Point and Rio Tuba in Palawan, and Selinog and Aliguay Islands in Mindanao.

Of the five fishing methods or gears known to kill cetaceans in the areas studied in the Philippines, purse-seines are thought to have the most impact. The author was aboard a commercial purse-seine vessel that carried four motorized boats. The net was approximately 740 m long and 110 m deep. The captain of this vessel estimated that each of the five purse-seiners caught 120 mt per month (2,400 to 3,600 mt for the four to six months which comprise the fishing season). The major tuna species caught are yellowfin tuna and bigeye tuna.

While aboard the vessel, the author did not witness any cetacean kills, although interviews indicated that "sizable numbers" of dolphins are caught by purse-seiners in the area. Two days before the author boarded the vessel, it apparently had caught 60 dolphins in a single set and another

20 dolphins in a set two weeks earlier. From this information, the author suggests one seiner catches an average of five dolphins per trip/day/set, or (assuming 15 days of fishing a month) 300-450 dolphins during the four to six month season. This extrapolates to 1,500 to 2,250 dolphins per season for this five vessel fleet, or one dolphin for every two tons of tuna caught. Both commercial and municipal purse-seining may or may not involve the use of FADs. Information on the total number of purse-seiners in the Philippines or on the proportion of sets made on FADs is not available. It is also not clear from the text if the dolphins kills described were incidental kills from intentional encircling of the dolphins, incidental kills from FAD sets or if the mortality occurred accidentally when an apparently non-associated tuna school was being encircled.

The ten municipal purse-seiners, specifications of which are found in the text, operating out of Basay catch about three dolphins per boat per week which consists of five fishing days. Thus, these ten boats from Basay may account for 480-720 dolphins killed during the principal fishing season (four months). The ten boats together catch "about ten dolphins" during the remaining months raising the total to 490-730 dolphins killed per year. A photograph of three spinner dolphins killed in a purse-seine net accompanies the text.

Barrett, I. 1991. Purse-seine sets on marine mammals. Memorandum to Gary Smith. Southwest Fisheries Science Center, 17 May 1991.

Marine mammal sets made by U.S. purse-seiners in the western Pacific Ocean (Fig. 3), 1988-1990 are presented in this memorandum. Data collected from purse-seine vessel catch report forms completed by U.S. licensed purse-seiners operating in the western Pacific Ocean. No data are available on mortality. No further information on the data source given.

Year	Sets on dolphins	Sets on whales	Total Sets
1988	0	2 (0.6%)	3386
1989	4 (0.6%)	0	6408
1990	0	0	162

The memorandum also reports the number of purse-seine sets made on "floating objects, sharks, and marine mammals" in the western Pacific Ocean by the Japanese, 1973-1977. Data on number or percentage of sets made only on marine mammals were not available. No further

information on the data source is given.

	Type of tuna school	
Year	**Yellowfin**	**Skipjack**
1973	380	110
1974	546	214
1975	1140	1520
1976	2697	424
1977	1614	852

Hampton, J. and K. Bailey. 1993. Fishing for tunas associated with floating objects: A review of the western Pacific fishery. South Pacific Commission, Tuna and Billfish Assessment Program. Tech Rep. No. 31, 48.

Data colected by the South Pacific Commission and stored in their Regional Tuna Fisheries Database on tuna fishing in the western Pacific includes a category for "animal sets". The percentage of total sets recorded as "animal sets" by each vessel nationality in the SPC Regional Tuna Fisheries Database follows.

Vessel Nationality	**Percent "Animal Sets"**
Australia	4.60
Indonesia	1.83
Japan	2.75
Korea	5.16
Mexico	3.07
New Zealand	0.0
Philippines	0.04
Solomon Islands	0.0
Soviet Union	0.02
Taiwan	0.27
United States	0.12
Total	1.88

Nearly 50% of all animal sets are unsuccessful suggesting, according to the authors, that most "animal sets" involve live whales. Species and size composition of purse-seine catches by association, geographical distribution of "animal sets" by quarter, and distribution of "animal sets" by time of day and by quarter are also given.

The report also summarizes the results of a series of exploratory charters conducted in the western Pacific between 1974 and 1984. Ten U.S. seiners experienced in tuna-dolphin fishing recorded 190 dolphin schools over a period of 772 searching/fishing days. Sixty-one (30%) of the

190 dolphin schools were of the three preferred species (*Stenella attenuata*, *S. longirostris*, *Delphinus delphis*). In two instances tuna-dolphin associations were set upon (see Anon., 1977). The authors also refer to more recent reports on Japanese and U.S. seiners in which no sets on dolphins were recorded. An SPC tagging vessel, *Te Tautai*, sighted and fished 1,794 tuna schools in the western Pacific Ocean (excluding Indonesia and the Phillippines) over the last two years. Only one of these schools, found in northern Papua New Guinea waters, was associated with dolphins which were tentatively identified as spinner dolphins. The authors note, however, that this vessel has fished on six tuna-dolphin associations (2.3% of all schools fished on) in the archipelagic waters of Indonesia and the Philippines. These associations involved either skipjack or mixed schools of skipjack and "small to medium-sized" yellowfin.

WESTERN ATLANTIC

Caldwell, D.K. and M.C. Caldwell. 1971. Porpoise fisheries in the southern Caribbean: Present utilizations and future potentials. Pages 195-205 *in* Proceedings of the 23rd Annual Session, Gulf and Caribbean Institute, Willemstad, Curacao, November 1970.

The authors report: "While the species involved have yet to be documented fully, in recent years we have been told (by Stewart Springer and Harvey R. Bullis, for example) that porpoises are indeed sometimes seen in association with tuna schools in the tropical and temperate western Atlantic."

Rinaldo, R.G., R.H. Evans and P.J. Vergne. 1980. Preliminary results of a 1980 skipjack tuna tagging cruise in the western Atlantic and Caribbean Sea. National Marine Fisheries Service, Southwest Fisheries Science Center, Admin. Rep. LJ-80-18. 28.

The authors participated in a skipjack tuna tagging cruise between 4 February and 18 April 1980 in the western Atlantic and Caribbean Sea. The area of investigation was centered in the Caribbean Sea and extended from the Dominican Republic along the Lesser Antilles and southeast along the coast of South America to French Guiana. Marine mammal observations were recorded during all but the first three days of the cruise. The majority (84.3%) of tuna schools were associated with birds. There are two places in text that discuss marine mammal sightings. The authors first state that none of the schools "appeared" to be associated with marine mammals although whales and dolphins were sighted "often." Yet later in the text they report that marine mammal sightings were "infrequent" and that only in one case were tuna observed in the same area as marine mammals (the species involved is not given). The authors provide a list of how often each cetacean species was sighted, but no further information on the sightings is provided. Seven species of whales and four species of dolphins were recorded.

Alverson, F.G. 1991. Tuna purse-seine and gill/drift net fisheries in the oceans of the world and their relationship to tuna-dolphin, tuna-whale and tuna-whale shark associated schools. Report prepared for CAAINPES Seccion Especializada en Pesca de Atun, Programa Atun-Delfin, Camara Nacional de la Industria Pesquera. July, 1991. 110 pp.

Alverson cites Caldwell and Caldwell (1971) regarding the potential for a tuna purse-seine fishery to develop in the region and the possible effect it may have on dolphin populations given that dolphins have "sometimes" been seen in association with tuna in the area. In addition, Alverson cites a 1982 Living Marine Resources report, which documents the sighting of a dolphin school associated with tuna in the Gulf of Mexico. Alverson reports on anecdotal information he collected himself and information regarding Venezuelan seiners using whales to detect associated tuna schools (see below Medina-Gaertner and Gaertner 1991).

Medina-Gaertner, M. and D. Gaertner. 1991. Factores ambientales y pesca atunera de superfice en el mar Caribe. ICCAT, Coll. Vol. Sci. Papers. 36:523-536.

The authors selected the "most precise" logbook data from Venezuelan purse-seiners operating in the southern Caribbean Sea between 1987 and the first quarter of 1989. The sample consisted of 2,199 tuna school sightings of which 22.9% were located with whales. Eighty-one percent of all skipjack schools occurred as free schools. Yellowfin schools were associated with whales or blue sharks 52% of the time.

MEDITERRANEAN SEA

Di Natale, A. 1983. Striped dolphin, *Stenella coeruleoalba* (Meyen) in the central Mediterranean Sea: An analysis of the new data. Rapp. Comm. int. Mer Medit. 28(5):201-202.

Di Natale reports that 21 striped dolphins were captured in tuna purse-seine nets in two separate incidents in the Ligurian Sea. All but one of the dolphins was released alive.

Magnaghi, L. and M. Podesta. 1987. An accidental catch of eight striped dolphins, *Stenella coeruleoalba* (Meyen, 1833), in the Ligurian Sea. Atti. Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano. 128(3-4):235-239.

The authors, aboard a 24 m tuna purse-seine vessel operating 45 miles off San Remo in the Ligurian Sea, observed the entrapment of eight striped dolphins on 6 September 1986. The dolphins had not been seen when the net was lowered around the feeding tuna school. Of the eight dolphins captured, five did not survive and the remaining three were released alive. One hundred tuna, *Thunnus thynnus*, were brought in with the net. A photograph of dolphins trapped in the net and one of a dead dolphin accompany the text.

Hernandez, V.A. 1990. The tuna fishery in the eastern Adriatic. ICCAT, Coll. Vol. Sci. Papers. 33:101-107.

The first tuna boat equipped with a purse-seine net was used in the eastern Adriatic Sea around 1929. From 1965 to the present, purse-seining has been the sole method for catching tuna. Bluefin tuna make up on average 77.3% of the tuna catch (over a 43 year time period) with smaller tunas comprising the rest of the catch. Tuna fishing grounds are concentrated in the northeastern portion of the Adriatic Sea (more detailed descriptions of catch locations are given in the text). The Yugoslav fleet, numbering 14 vessels in 1989, makes 95% of the total bluefin catch. Over 90% of the catch is made at night by Yugoslav purse-seiners which may fish alone, in pairs or in groups. Tuna schools are located by visual cues from the tuna themselves or by the "inferred association with schools of dolphins and with floating objects." Information on fishing areas, fishing seasons and length/weight distributions of catches can be found in the text. However there are no catch statistics by association type.

Di Natale, A. 1990a. Interaction between marine mammals and scombridae fishery activities: The Mediterranean case. FAO Fish. Rep. 449:167-174.

Di Natale reports that interactions between purse-seiners fishing for small pelagic fishes and marine mammals "rarely" have been reported. However, he adds that tuna purse-seiners are known to capture striped dolphins, pilot whales and other Delphinidae with a "higher" frequency even if the total number of captures per year is low.

Silvani, L., J. Raich and A. Aguilar. 1992. Bottle-nosed dolphins, *Tursiops truncatus*, interacting with local fisheries in the Balearic Islands, Spain. European Research on Cetaceans. No. 6. Proceedings of the Sixth Annual Conference of the European Cetacean Society, San Remo, Italy. 20-22 February 1992. p. 29. [Abstract]

The authors carried out a field survey in the Balearic Islands in the summer of 1991 to better determine the interactions between fisheries and marine mammals in the area. The Balearic fishing fleet consists of 780 ships of which 16 (1.76%) are purse-seiners. They conducted interviews with 18% of the fleet's fishermen. It is not clear how many of the interviews were with fishermen who use purse-seine gear. Nevertheless, because the purse-seine fleet is small and operates in a limited area (Palma Bay), interactions with dolphins are considered "exceptional."

SUMMARY

The sequence of references reviewed here follows roughly the development of tuna purse-seine fisheries around the tropical waters of the globe subsequent to gear developments and ETP fishing successes in the early 1960's. The 21 references from the eastern Atlantic region span the years 1961 to 1994, for example, with 16 of these containing original data. The 20 references from the western Pacific range from 1972 to 1993, and the 14 references from the Western Indian Ocean range from 1982-1995. The earliest reference from the western Atlantic occurred in 1971; the earliest from the Mediterranean Sea in 1983. Thus reports from non-ETP tuna-purse-seine fleets, particularly those incorporating the large (greater than about 400 tons) vessels, have been appearing for about 20-25 years.

Each of these geographically-defined fleets tend to use only a few ports, so that an apparent concentration of non-ETP tuna purse-seine effort on dolphins may appear in the records when in fact the actual areas of fishing might be quite widely distributed. Nevertheless, the concentration of vessel activity at particular ports may provide a starting point for future investigations into this question.

Eastern Atlantic Summary. Most records are taken from vessels using the ports of either Abijan or Dakar (Figure 1). Most of the references indicate relatively few sets made on dolphins (fewer than 10% of observed or logged sets, usually fewer than 1-2% of observed or logged sets: Bane 1961, Honma 1969, Coan and Sakagawa 1982, Pereira 1985, Strell et al. 1986, Baird 1990, Pereira 1990, Santana, 1990, Ariz et al. 1991, Ariz et al. 1992, and Nores 1992). Verbal statements that tuna-dolphin associations are "rare" can be found in Levenez 1980 and Maigret 1994. Opposing references indicating that tuna-dolphin purse-seine activity is in fact prevalent in the eastern Atlantic Ocean include one reference with data, indicating that common dolphins were caught in 8 of 40 sets off Cape Palmas (Simmons 1968), and three with verbal statements that tuna-dolphin are, "taken too much" (Palma 1970), "common" (van Bree 1971), "sometimes" (Maigret 1981a) and "not unusual" (Arbex 1990).

Obviously opinions differ, although the bulk of actual data indicate relatively little tuna-dolphin activity in the eastern Atlantic Ocean.

Indian Ocean Summary. Most of the information from this area has been gathered around the Seychelles, Sri Lanka, and in the Arabian Sea. As with the eastern Atlantic, most references from the Indian Ocean indicate little or no association between dolphins and tuna. Most references indicate fewer than 10% of observed or logged sightings or sets on tunas associated with dolphins (Marsac 1983, Marsac et al. 1982, Potier and Marsac 1984, Stequart 1986, Montaudouin et al 1990, Subadach and Hollier 1993). Verbal statements also indicate that tuna-dolphin associations are very rare" (Marsan and Hollier 1985) and "practically non-existent" (Montaudouin et al. 1990). However, also similar to the situation in the eastern Atlantic, some other references from the Indian Ocean imply that dolphins may be involved in tuna fishing, particularly in more local fisheries using smaller boats and different methods than the large commercial purse-seiners (e.g., deSilva and

Boniface 1991, Alling 1992).

Again, opinions obviously differ, although the bulk of actual data indicate relatively little tuna-dolphin activity in the Indian Ocean.

Western Pacific Ocean Summary. This enormous area includes Micronesia, Polynesia, Japan and the Philippines (Figures 3, 4, 5). Most references indicate little if any purse-seine effort involving dolphins in any area of the western Pacific (Ohsumi 1972 (north Pacific), Anon. 1974 (French Polynesia), Anon. 1977 (western Pacific), Honma and Suzuki 1978 (western Pacific), Souter and Broadhead 1978 (central and western Pacific), Anon. 1979 (north and northwest of New Guinea), Burns and Souter 1980 (west and south of Hawaii), Solomons and Souter 1980 (western Pacific) , Souter and Solomons 1980a (western Pacific), Solomons and Souter 1980b (northwest of Hawaii and western Pacific), Anon. 1982 (New Zealand), Bailey and Souter 1982 (western Pacific), Lambert 1984 (northwest of Hawaii and the Line Islands), Patterson and Alverson 1986 (central and western Pacific), Hampton and Bailey 1993 (western Pacific).

Verbal statements indicating little if any purse-seine effort on dolphins in the western Pacific include "Australian purse-seiners do not fish on dolphins (Bannister 1977) and "tuna are rarely observed in association with porpoise" (Anon. 1977). Several references indicate that dolphins are present in varying numbers in the western Pacific but state that these dolphins tend not to be associated consistently with tuna and so are rarely set upon (Anon. 1974, Anon. 1977, Souter and Broadhead 1978, Anon. 1979, Burns and Souter 1980, Salomons and Souter 1980, Souter and Salomons 1980a, Solomons and Souter 1980b, Bailey and Souter 1982, Patterson and Hampton 1986, and Hampton and Bailey 1993).

The majority of marine mammal-tuna associations that do appear in the records are associations with large whales (e.g., Anon.1977, Honma and Suzuki 1978, Souter and Broadhead 1978, Burns and Souter 1980, Salomons and Souter 1980, Souter and Salomons 1980b, Lambert 1984).

The only two areas for which more than a very few incidental mortalities were mentioned were the coastal areas of Japan (Ohsumi 1972; Japanese coastal purse-seiners, and Miyazaki 1983) and around the Philippine Islands (Dolar 1990; municipal purse-seiners). In these areas, reported mortalities included 2 sets within 2 weeks capturing 60 and 20 dolphins, respectively (Dolar 1990), mortality of 60 dolphins in a 5 year period (Miyazaki 1983), and about 1 ton of dolphins per year by coastal Japanese purse-seiners and 0.2 tons per year by purse-seiners in the "north Pacific" (Ohsumi 1972).

A large proportion of these references present data collected during exploratory fishing purse-seine surveys by U.S. vessels in the western Pacific following decline of fishing success in the eastern tropical Pacific, and so may be suspect due to an obvious interest in minimizing the potential for problems in the western and central Pacific similar to those resulting from the practice of fishing "on dolphin" in the ETP (e.g., Anon. 1974, Anon. 1977, Souter and Broadhead 1978, Burns and

Souter 1980, Salomons and Souter 1980, Souter and Salomons 1980a, Solomons and Souter 1980b, Bailey and Souter 1982, Lambert 1984, Patterson and Alverson 1986). However, the general picture presented by these survey reports, of dolphin presence but little consistent association with tuna, is supported by the few references from other sources (e.g., Honma and Suzuki 1978, Anon. 1982, Hampton and Bailey 1993).

Data collection by objective scientific agencies may be the only route to a truly unbiased picture of dolphin mortality in the western Pacific incidental to purse-seine operations, but the data available to date imply relatively low mortality.

Western Atlantic Summary. Very few reports exist. Dolphins have been sighted in the Caribbean (Rinaldo et al. 1980), and reportedly are "sometimes" associated with tuna (Caldwell and Caldwell 1971), but no source indicates any consistent association between dolphins and tunas.

Mediterranean Sea Summary. Very few reports exist. There is no indication of any consistent directed effort on or existence of tuna-dolphin associations (Hernandez 1990, Adriatic Sea; Silvani and Aguilar 1992, Balearic Islands), although accidental catches have been reported, particularly of striped dolphins, have been reported twice (DiNatale 1983, 2 sets; Magnaghi and Podesta 1987, 1 set).

CONCLUSIONS

There are no records of consistent or widespread fishing effort on tuna-dolphin associations anywhere other than in the ETP. Dolphin schools of various species and sizes are apparently sighted regularly in many of the other geographic areas where yellowfin tuna are regularly captured by purse-seine, but fishable tuna-dolphin associations are apparently relatively rare. The most common tuna-marine mammal association outside the ETP appears to be with large whales and even these associations apparently account for only a small percentage of total purse-seine effort on tunas outside the ETP.

An obvious problem with concluding from the above statements that incidental mortality of dolphins in tuna purse-seines outside the ETP is minimal is that many of the existing reports have been produced by groups with vested interests in one or another viewpoint: groups related to commercial fishing interests will obviously hope to find little evidence of tuna-dolphin problems similar those occurring in the ETP, while groups related to environmental concerns will be especially sensitive to even slight indications of potential problems. While verbal statements in the references reviewed here tend to support one or the other viewpoint depending upon the author's affiliation, the data presented support only the conclusion that tuna-dolphin associations are relatively rare outside the ETP and thus receive very little fishing effort.

As stated in reference to the situation in the western Pacific, data collection by objective scientific agencies may be the only route to a truly unbiased picture of dolphin mortality incidental to purse-seine operations, but the data available to date imply relatively low mortality due to large

commercial purse-seiners fishing in pelagic (i.e., not coastal) areas outside the ETP. Dolphin mortalities may be higher in coastal areas where accidental catches in smaller purse-seines appear to occur more or less frequently, but there is no evidence that these catches result from directed chase and capture methods such as those used by the large vessels in the ETP.

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LITERATURE CITED

Alling, A., J. Gordon, N. Rotton, and H. Whitehead. 1982. WWF-Netherlands Indian Ocean Sperm Whale Study, 1981-1982, Interim Report. IWC, Working Paper. IWC/SC/34Sp. 9.

Alling, A. 1985. Incidental records of small cetaceans in the northern Indian Ocean (1981-1982) and off the coast of Sri Lanka (1982-1984). Paper submitted to Int. Whal. Comm. 36, 1986 SC/37/SM4.

Alverson, F.G. 1991. Tuna purse-seine and gill/drift net fisheries in the oceans of the world and their relationship to tuna-dolphin, tuna-whale and tuna-whale shark assòciatèd schools. Report prepared for CAAINPES Seccion Especializada en Pesca de Atun, Programa Atun-Delfin, Camara Nacional de la Industria Pesquera. July, 1991. 110 pp.

Anon. 1974. *Sea Treasure* cruise. 15 October to 10 December 1974. Pacific Tuna Development Foundation Report. 29.

Anon. 1977. Pacific Tuna Development Foundation. Final Report. Tuna purse-seine charter to the western Pacific, July-November, 1976. Apollo, Mary Elizabeth, and Zapata Pathfinder. 47.

Anon. 1979. Tuna purse-seining cruise report, July 1978 - February 1979, *Bold Venture*. Pacific Tuna Development Foundation Report. 35.

Anon. 1982. New Zealand. Progress report on cetacean research, May 1980 to May 1981. Rep. Int. Whal. Commn. 32:189-195.

Arbex, J.C. 1990. Pescatores Espagnoles. Ministerio de Agricultura Pesca y Alimentacion. Secretaria General de Pesca Maritima, Madrid.

Ariz, J., P. Pallarés, A. Delgado de Molina and J.C. Santana. 1991. Análisis de los datos obtenidos en campañas de observadores en el Atlantico intertropical durante el Programa Año del Rabil. ICCAT, Coll. Vol. Sci. Papers. 36:109-123.

Ariz, X., A. Delgado, A. Fonteneau, F. A. Gonzales Costas and P. Pallarés. 1992. Logs and tunas in the eastern tropical Atlantic. A review of present knowledges and uncertainties. Working Document for IATTC WG, La Jolla, February, 1992.

Bailey, K. and D. Souter. 1982. Tuna purse-seine cruise report, June 2 - August 10, 1982, M/V *Western Pacific*. Final Report. Pacific Tuna Development Foundation. 37.

Bane, G.W. Jr. 1961. The distribution and abundance of tunas and tuna bait fishes in the Gulf of Guinea. M.S. Thesis, Cornell U. 119.

Bannister, J.L. 1977. Incidental catches of small cetacea off Australia. Rep. Int. Whal. Commn. 27:25.

Bard, F.X. and A. Herve. 1990. Note sur le signalment de dauphins en association avec les thons tropicaux en Atlantique est. ICCAT, Working Document, SCRS/90/70. 8.

Barrett, I. 1991. Purse-seine sets on marine mammals. Memorandum to Gary Smith. Southwest Fisheries Science Center, 17 May 1991.

Burns, F. and D. Souter. 1980. Tuna purse-seining cruise report, June-August 1980, *White Star*. Report by Living Marine Resources, Inc. 29.

Caldwell, D.K. and M.C. Caldwell. 1971. Porpoise fisheries in the southern Caribbean: Present utilizations and future potentials. Pages 195-205 *in* Proceedings of the 23rd Annual Session, Gulf and Caribbean Institute, Willemstad, Curacao, November 1970.

Cayre, P., J.B. Amon Kothias, T. Diouf and J.M. Stretta. 1988. Biologie des thons. Pages 157-268 *in:* A. Fonteneau and J. Marcille, eds. Ressources, pêches et biologie des thonidés tropicaux de l'Atlantique Centre-Est. FAO Doc. Tech. Pêche 292.

Coan, A.L. and G.T. Sakagawa. 1982. An examination of single set data for the U.S. tropical tuna purse-seine fleet. ICCAT, Coll. Vol. Sci. Papers. 18:83-94.

de Silva, J. and Boniface, B. 1991. The study of the handline fishery on the west coast of Sri Lanka with special reference to the use of dolphin for locating yellowfin tuna (*Thunnus albacares*). IPTP (FAO). Coll. Vol. Work. Doc. Vol 4. TWS/90/18.

Di Natale, A. 1983. Striped dolphin, *Stenella coeruleoalba* (Meyen) in the central Mediterranean Sea: An analysis of the new data. Rapp. Comm. int. Mer Medit. 28(5):201-202.

Di Natale, A.1990a. Interaction between marine mammals and scombridae fishery activities: The Mediterranean case. FAO Fish. Rep. 449:167-174.

Di Palma, S. 1970. Memorandum to G. Howard and response from A. Longhurst regarding French tuna fishery out of Abidjan, Ivory Coast.

Dolar, M.L.L. 1990. Incidental takes of small cetaceans in fisheries in Palawan, central Visayas and northern Mindanao in the Philippines. Rep. Int. Whal. Commn (Special Issue 15). 355-363.

Eyre, E. J. 1995. Observations of cetaceans in the Indian Ocean Whale Sanctuary, May-July 1993. Rep. Int. Whal. Commn 45:419-426.

Hampton, J. and K. Bailey. 1993. Fishing for tunas associated with floating objects: A review of the western Pacific fishery. South Pacific Commission, Tuna and Billfish Assessment Program. Tech Rep. No. 31, 48p.

Hernandez, V.A. 1990. The tuna fishery in the eastern Adriatic. ICCAT, Coll. Vol. Sci. Papers. 33:101-107.

Honma, M., K. Hisada and S. Kanno. 1969. Tuna fisheries with the use of pole-and-line and purse seine, and their yellowfin stocks along the western coast of equatorial Africa. Bull. Far Seas Fish. Res. Lab. No. 2. 85-113.

Honma, M. and Z. Suzuki. 1978. Japanese tuna purse-seine fishery in the western Pacific. Far Seas Fish. Res. Lab. No. 10, S series. 66. [In Japanese]

Lambert, J.F. 1984. Tuna purse-seine cruise report, July 21-November 9, 1983, M/V *Jo Ann*. Final Report. Report prepared by Living Marine Resources for Pacific Tuna Development Foundation. 38.

Leatherwood, S., C.B. Peters, R. Santerre, M. Santerre and J.T. Clarke. 1984. Observations of cetaceans in the Northern Indian Ocean Sanctuary, November 1980-May 1983. Rep. Int. Whal. Commn. 34:509-520.

Levenez, J., A. Fonteneau and R. Regalado. 1980. Resultats d'une enquête sur l'importance des dauphins dans la pêcherie thonière FISM. ICCAT, Coll. Vol. Sci. Papers. 9(1):395-400.

Magnaghi, L. and M. Podesta. 1987. An accidental catch of eight striped dolphins, *Stenella coeruleoalba* (Meyen, 1833), in the Ligurian Sea. Atti. Soc. ital. Sci. nat. Museo civ. Stor. nat. Milano. 128(3-4):235-239.

Maigret, J. 1981a. Rapports entre cétacés et la pêche thonière dans l'Atlantique tropical oriental. Notes Africaines. 171:77-84.

Maigret, J. 1981b. Rapports Mammiferes Marins/Pêche dans l'Atlantique tropical. GEMMATA. No. 3:9.

Maigret, J. 1994. Marine Mammals and fisheries along the west African coast. Rep. Int. Whal. Commn (Special Issue 15):307-316.

Marsac, F. 1983. Radiometrie aerienne et prospection thoniere aux Seychelles. Mission ORSTOM aux Seychelles. Rapp. Sci. No.2. 82.

Marsac, F., B. Piton, M. Potier and B. Stéquert. 1983. Campagne expérimentale de pêche à la senne du thonier "Yves de Kerguelen" dans l'ouest de l'ocean Indien tropical. Mission ORSTROM aux Seychelles. Rapp. Sci. No. 3. 112.

Marsac, F and J.P. Hallier. 1985. Environment et pêche thonière de surface dans l'ocean Indien occidental (1983-1984). Antenne ORSTROM aux Seychelles. Rapp. Sci. No. 5. 98.

Medina-Gaertner, M. and D. Gaertner. 1991. Factores ambientales y pesca atunera de superfice en el mar Caribe. ICCAT, Coll. Vol. Sci. Papers. 36:523-536.

Miyazaki, N. 1983. Catch statistics of small cetaceans taken in Japanese waters. Rep. Int. Whal. Commn. 33:621-631.

Montaudouin, X. de; J.P. Hallier and S. Hassani. 1990. Analyse des données collectées lors des embarquements à bord des senneurs basés aux Seychelles (1986-1989). SFA Tech. Rep., SFA/R&D/014. 34.

Nores, C., C. Pérez and J.A. Pis-Millán. 1992. Cetacean bycatches in the central Cantabrian Sea: Fishing gear selectivity. European Research on Cetaceans. No. 6. Proceedings of the Sixth Annual Conference of the European Cetacean Society, San Remo, Italy. 20-22 February 1992. p. 29. [Abstract]

Ohsumi, S. 1972. Catch of marine mammals, mainly of small cetaceans, by local fisheries along the coast of Japan. Far Seas Fish. Res. Lab. Bulletin 7, November 1972. 137-166.

Patterson, P. and F. Alverson. 1986. Summary of spotted, spinner, unidentified and other identified porpoise sightings reported by commercial tuna vessels fishing in the tropical central and western Pacific Ocean. National Marine Fisheries Service, Southwest Fisheries Science Center, Admin. Rep. LJ-86-06C. 25.

Pereira, J. 1985. Composition spécifique des bancs de thonidés pêches à la senne, aux Açores. ICCAT, Coll. Vol. Sci. Papers. 25:395-400.

Pereira, J. 1990. Indices de détection et taille des thons dans les bancs associés à objets flottants. ICCAT, Coll. Vol. Sci. Papers. 35(1):192-195.

Potier, M. and F. Marsac. 1984. Pêche thonière dans l'Ocean Indien: Campagne exploratoire d'une flotille de senneurs (1982-1983). Mission ORSTROM aux Seychelles. Rapp. Sci. No. 4. 88.

Rinaldo, R.G., R.H. Evans and P.J. Vergne. 1980. Preliminary results of a 1980 skipjack tuna tagging cruise in the western Atlantic and Caribbean Sea. National Marine Fisheries Service, Southwest Fisheries Science Center, Admin. Rep. LJ-80-18. 28.

Sabadach, B. and J.P. Hallier. 1993. Analyse des donneés collecteés lors des embarquements à bord des senneurs basés aux Seychelles (1986-1991). SFA Tech. Rep., SFA/R&D/024. 44.

Salomons, R. and D. Souter. 1980. Tuna purse-seining, *Island Princess* Cruise Report, June to October, 1979. Report prepared for the Pacific Tuna Development Foundation by Living Marine Resources.

Santana, J.C., J. Ariz, P. Pallarés and A. Delgado de Molina. 1990. Nota sobre la presencia de mamíferos marinos en la pesquería de tunidos al cerco en la Atlantico este intertropical. ICCAT, Coll. Vol. Sci. Papers. 25: 196-198.

Silvani, L., J. Raich and A. Aguilar. 1992. Bottle-nosed dolphins, *Tursiops truncatus*, interacting with local fisheries in the Balearic Islands, Spain. European Research on Cetaceans. No. 6. Proceedings of the Sixth Annual Conference of the European Cetacean Society, San Remo, Italy. 20-22 February 1992. p. 29. [Abstract]

Simmons, D.C. 1968. Purse-seining off Africa's west coast. Comm. Fish. Rev. March, 1968. pp 21-22.

Souter, D. and G. Broadhead. 1978. Purse-seine fishing for yellowfin and skipjack in the southern waters of the central and western Pacific, *Jeanette C.* charter. Pacific Tuna Development Foundation. Technical Bulletin 2. 77.

Souter, D. and R. Salomons. 1980a. Tuna purse-seining, cruise report, June-September 1980, *Island Princess*. Report by Living Marine Resources, Inc. 48.

Souter, D. and R. Salomons. 1980b. Tuna purse-seining, cruise report, *Jeanette C.*, May-September, 1979. Report prepared for the Pacific Tuna Development Foundation by Living Marine Resources, San Diego, California.

Stéquert, B. 1986. Prospections thonières de surface menées par les Japonais dans l'ocean Indien. La Pêche Maritime. 1302:646-651.

Stéquert, B. and F. Marsac. 1986. La pêche de surface des thonidés tropicaux dans l'ocean Indien. FAO Doc. Tech. Pêches, 282. 213.

Stretta, J.M. and M. Slepoukha. 1986. Analyse des facteurs biotiques et abiotiques associés aux bancs de thons. Pages 161-169 *in* P.E.K. Symons, P.M. Miyake, and G.T. Sakagawa, eds. Proceedings of the ICCAT Conference on the International Skipjack Year Program, Madrid, 1986.

Sudara, S. 1990. Dolphins in Thailand. IWC Working Paper, Symposium of Incidental Mortality of Marine Mammals in Passive Fishing Nets and Traps, Working Paper SC/090/G32. 3.

van Bree, P.J.H. 1971. Letter to V.B. Scheffer, 22 February 1971.

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Figure 1. Eastern tropical Atlantic

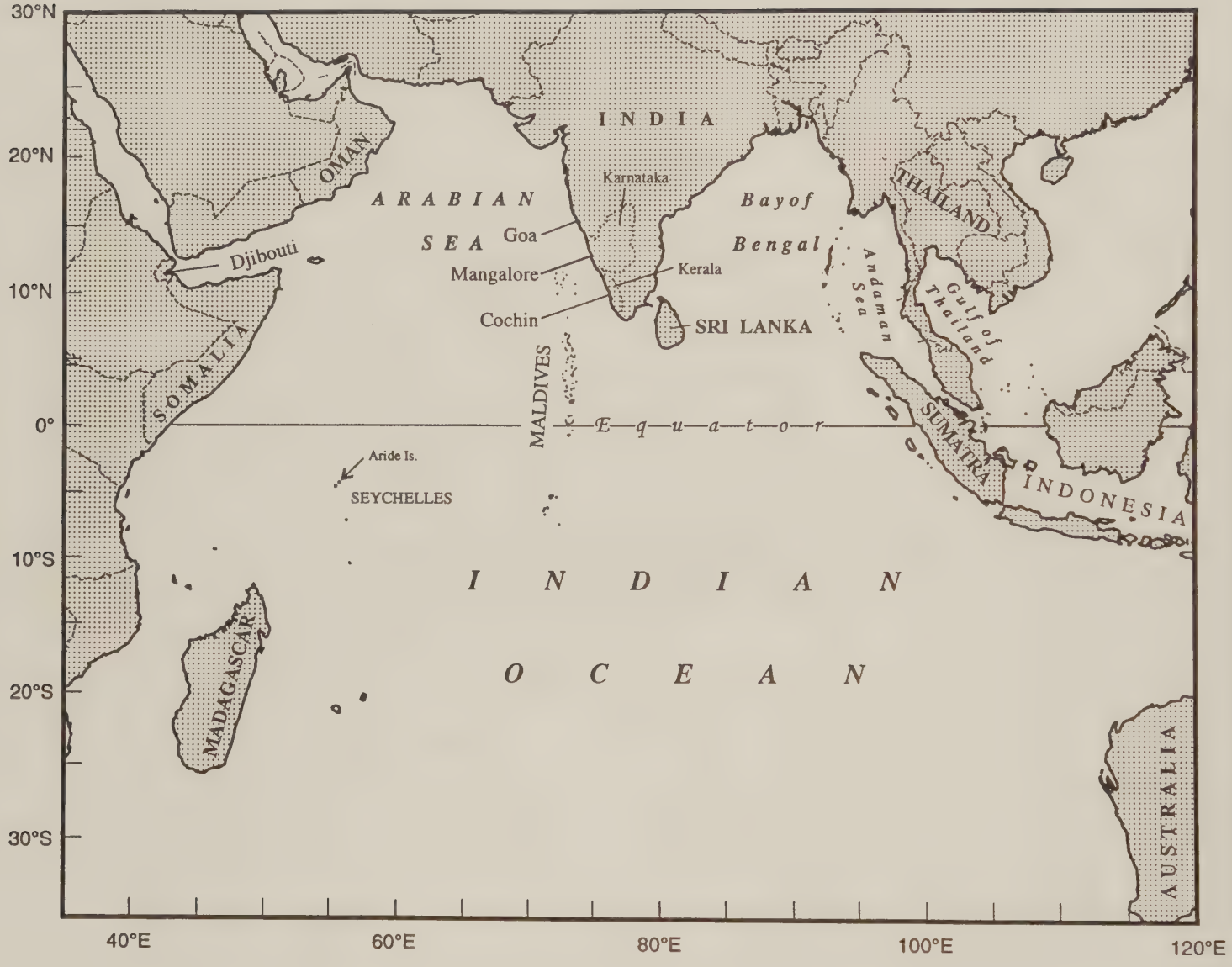

Figure 2. Indian Ocean

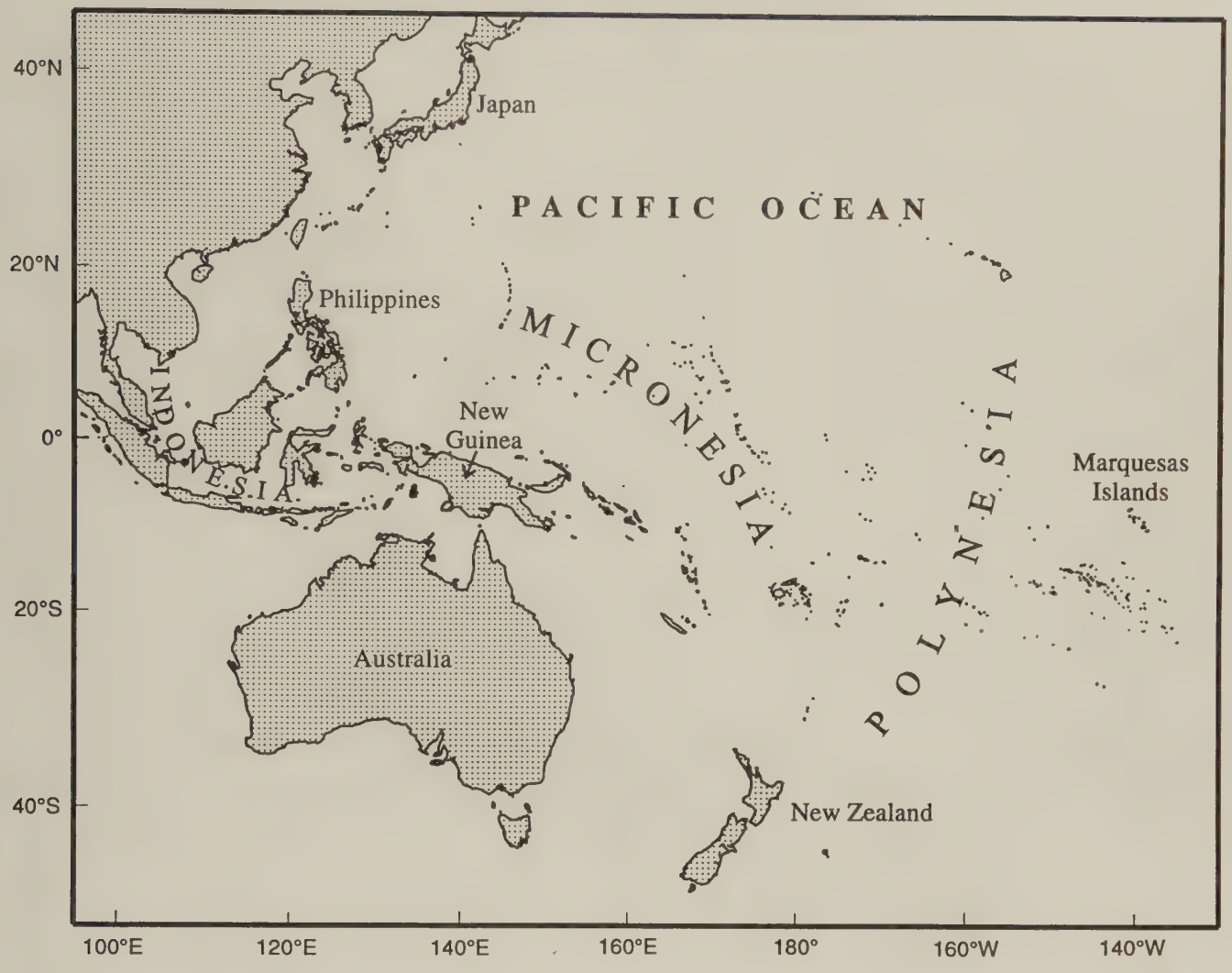

Figure 3. Southwestern Pacific Ocean

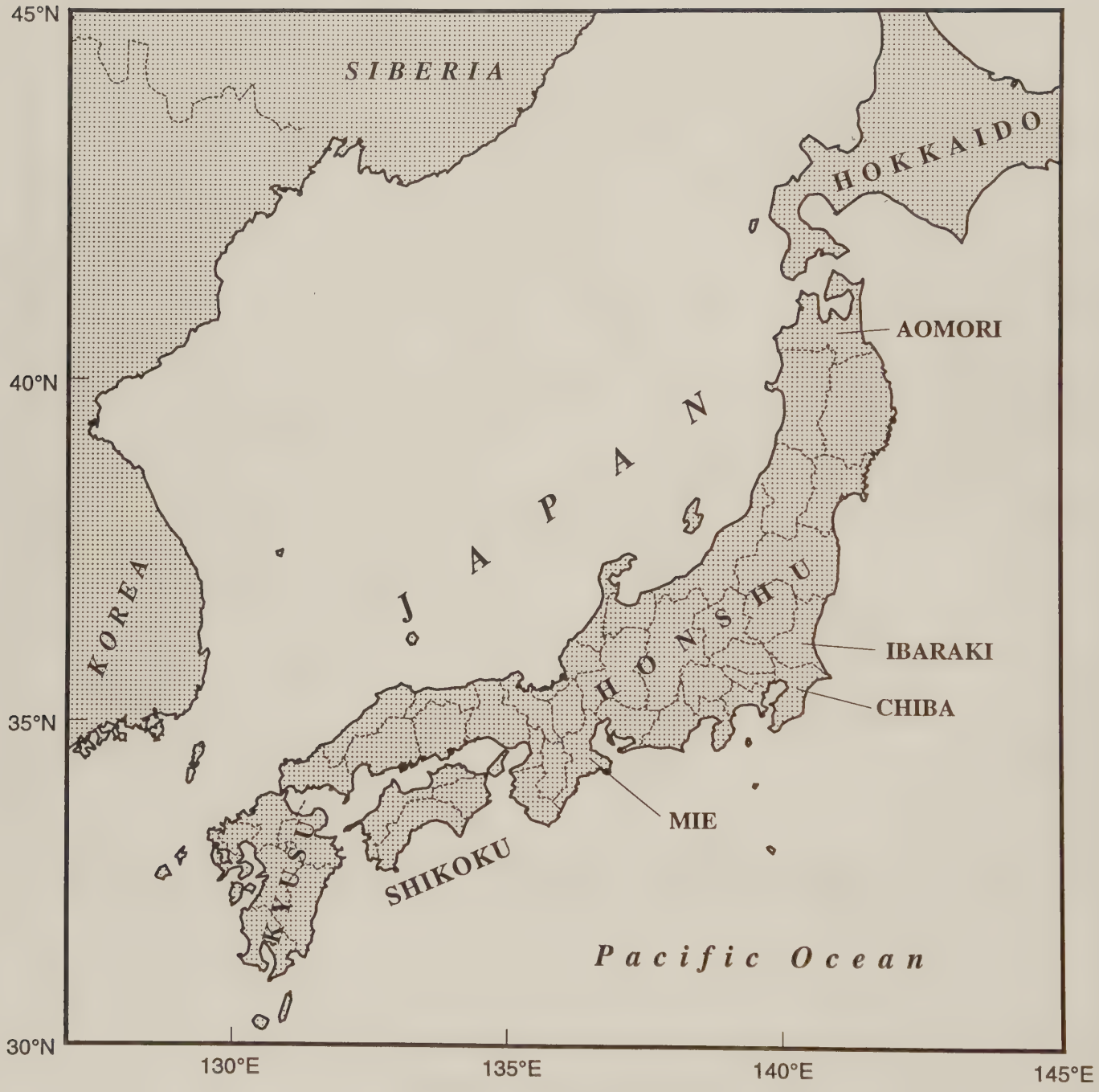

Figure 4. Japan

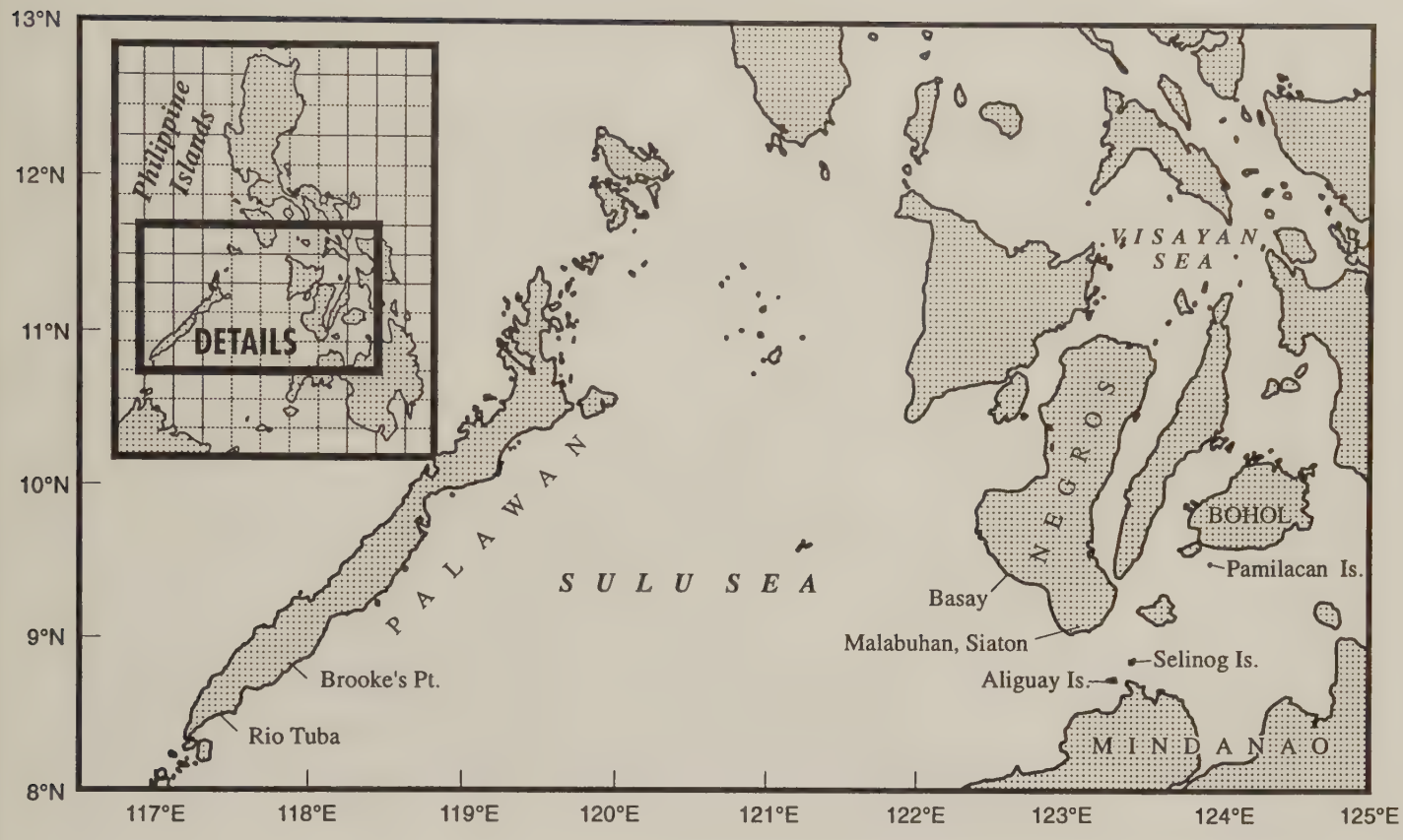

Figure 5. Philippine Islands

Figure 6. Western Atlantic

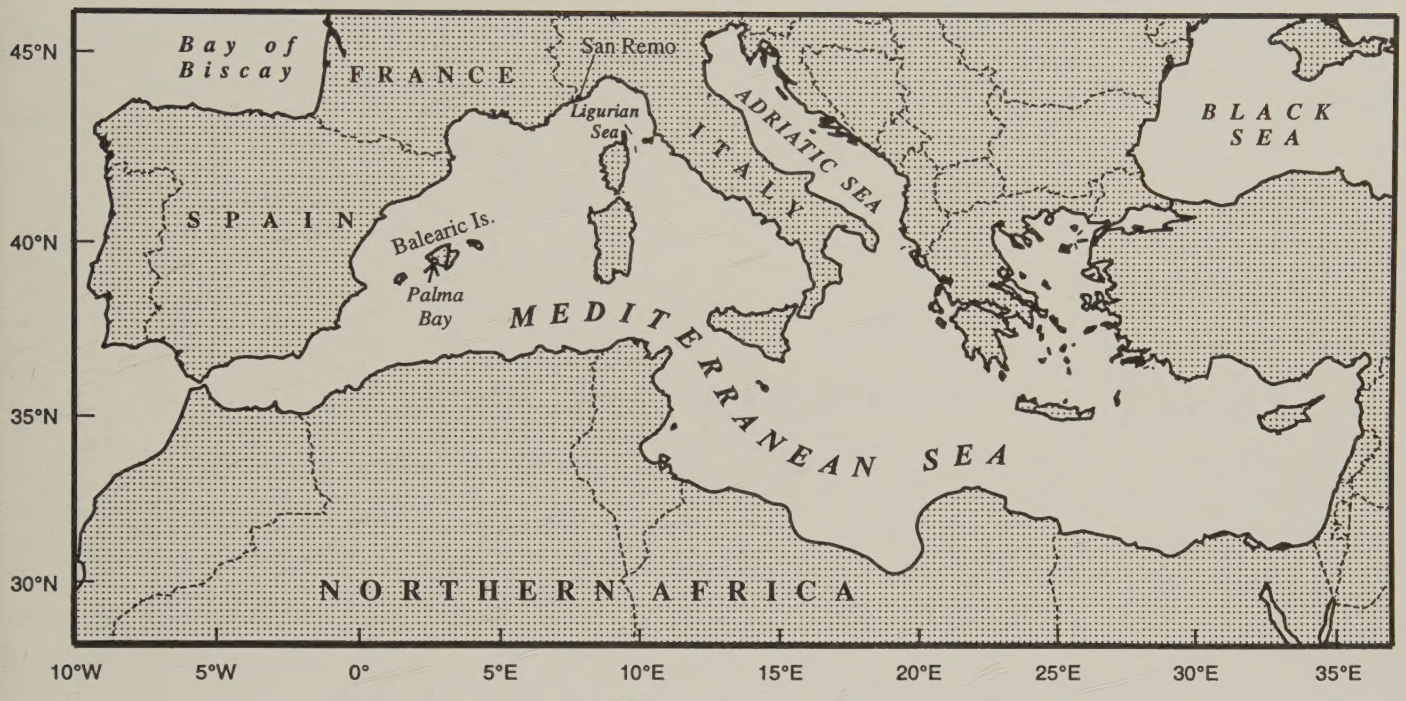

Figure 7. Mediterranean Sea